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THE PRINCIPLE OF COMPLEMENTARITY*

L. ROSENFELD

IF one wanted to condense into a pregnant formula the fundamental achievement of quantum theory, one would say that it has done away with the dualism of matter and force, which had been the *leit-motif* of scientific thinking since the days of Newton. According to quantum theory, every physical agency partakes of the properties expressed by these two concepts, and its material or dynamical aspect can, so to speak, be conjured up at will by suitably selecting the conditions of observation. Thus the same agency that usually presents itself to us as a field of electromagnetic force, spread out in space and time, can also appear in the form of a photon, i.e., a quantum of energy and momentum satisfying the conservation laws in the way characteristic for material particles. Again the agency familiarly known under its aspect of material particle as

the electron has dynamical functions of essential importance, e.g., in establishing molecular bonds of the homopolar type, which can only be described in terms of fields of force obeying specific wave-equations.

The integration of this new synthesis into our scientific thinking, however, raised a logical problem of a kind unprecedented in physics. It took years of hard thinking before the logical relationship between the two complementary aspects of physical reality could be completely elucidated. But the resulting doctrine of "complementarity", elaborated by Niels Bohr, exhibits such novel features that even to-day many people are reluctant to accept it. If we try to analyse the motives for this reluctance we find that they can all be referred to a common failure to realise the dialectic movement of scientific thought. One cannot attempt to arrest this thought at any stage of its unceasing development without closing one's mind to the understanding of its further progress.

The first point to realise is that the conception of complementarity forces itself upon us with logical necessity. It arises from an effort

* Abstract of a revised version of the author's contribution entitled "L'évidence de la complémentarité", to the collective volume *Louis de Broglie, physicien et penseur* (Paris, 1952), which appeared in *Science Progress* for July 1953.

to adapt our ideas to a novel experimental situation in the realm of atomic physics. We can therefore only judge whether it adequately fulfils its function by considering it in relation to our experience and its immediate interpretation. If we consider it from the standpoint of epistemology, we may be led to modify the theory of knowledge; we cannot possibly change the lessons of experience. The latter can be embodied mathematically in the form of the well-known uncertainty relations. But the decisive step is the physical interpretation of these relations. It is at this stage that the idea of complementarity is introduced by Bohr's famous analysis. In any account of atomic processes, a restriction is imposed on the concurrent use of "conjugate" concepts, such as position and momentum, because the system under investigation interacts with the apparatus used to observe it. Owing to the quantal features of this interaction, the measurement of any quantity pertaining to the system modifies the conjugate quantity to an extent which partly escapes our control and consequently limits the possibility of defining the second quantity in the circumstances of that particular measurement. This limitation, arising as it does from the very manipulation of the measuring apparatus, is clearly inevitable.

We are thus forced to the conclusion that classical determinism has only a limited validity; this limitation of determinism is not an arbitrary decree contrary to the spirit of science, but a necessary step which opens a way for a generalisation of considerable scope. We are here witnessing with striking clarity the unfolding of a dialectic movement according to the typical scheme. The impossibility of integrating the quantum of action into the body of deterministic laws of classical physics corresponds to the phase of "negation". This phase, dominated by the contradictions of the old quantum theory, ends with the formulation of quantum mechanics and its interpretation in the frame of complementarity. This is the "synthesis" in which these contradictions vanish to make room for a new harmony.

Determinism, as a general conception of the form of natural laws, is perfectly adapted to the description of phenomena on the macroscopic scale; but the danger lies in attempting to enforce it universally. The physicist who still clings to it, who shuts his eyes to the evidence of complementarity, exchanges the rational attitude of the scientist for that of the metaphysician, who, as Engels aptly describes him, considers things "in isolation, the one after

the other and the one without the other", as if they were "fixed, rigid, given once for all". Foremost among such is David Bohm, who has attempted to supply a deterministic substratum for quantum mechanics, in which the de Broglie wave would occur only as an auxiliary concept.[†] Yet all this seductive construction is just a sham. It is Bohm's pleasure to give his "hidden parameters" such names as co-ordinate and momentum, but it is a far cry from the name to the thing. In order to be sure that such and such a parameter really represents the position of a particle, it is necessary to examine its relation to the spatial system of reference of some observer, in other words, to analyse the measurement of the position. But then, as one would expect and as Bohm conscientiously proves, one finds that the identification of the parameters with the corresponding physical concepts is only justified within the limits of the uncertainty relations. Thus, in the end, his subtle and laborious circuit leads us back again to complementarity.

We may thus say that the idea of complementarity succeeds in reconciling a complete objectivity of the description of natural phenomena with the necessity of taking account explicitly, in this description, of the conditions of observation. From the dialectical point of view, it is almost self-evident to observe that the essential part played by the observer in the definition of the phenomena is perfectly consonant with the fundamentally materialistic character of science. For, materialism in the scientific sense is just the philosophical expression for the process of gradual refinement of our mental representation of the external world. Trouble can only arise if materialism becomes fossilised into some metaphysical system and anything not "dreamt of in this philosophy" is branded as "idealistic".

While emphasising the universal aspect of complementarity, Bohr is more keenly aware than anyone else of the danger of treating this conception metaphysically. He insistently warns us that in the evolution of physics complementarity is just a phase which we shall soon have to leave behind us. We can already discern the limits of the domain within which one can define complementary phenomena in the sense of the uncertainty relations. The problems raised by the field of nuclear force and the various particles associated with it demand for their elucidation new methods which will very probably mean a qualitative change in our con-

[†] *Phys. Rev.*, 1952, **85**, 166, 180.

ceptions comparable to that embodied in the passage from determinism to complementarity. But just as the laws of quantal phenomena and their complementarity relationships cannot be formulated without essentially making use of the deterministic laws of classical physics, likewise complementarity will necessarily form the

basis of new conceptions which will transcend it. In generalising determinism, complementarity does not destroy it; it rather makes it more fruitful and firmer by assigning it its proper limits. Likewise the future theory will reinforce complementarity by fixing its place within a still wider synthesis.

ROCKEFELLER GRANTS FOR INDIAN INSTITUTIONS

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Sawai Man Singh Medical College, Jaipur: \$22,345 for research equipment and facilities for breeding and maintenance of experimental animals; *Christian Medical College, Vellore*: \$10,000 for equipment and other facilities necessary for upgrading its Pathology Department; *G. S. Medical College, Bombay*: \$5,800 for equipment necessary to supply the Department of Pharmacology with minimum facilities for recognition as a Graduate Training Centre; *Dr. Jacob Chandy, Professor and Head of the Department of Neurosurgery and Neurology at Christian Medical College, Vellore*: \$4,000 to visit centres of neurosurgery and to observe new methods of medical education in Europe, the U.S.A. and Canada; *Dr. Yudhveer Sachdeva, Medical College, Amritsar*: \$4,000 to observe thoracic survey work in the U.S.A. and Canada; *Dr. S. K. Menon, Dean of the Faculty of Medicine of the University of Rajaputana and Principal of the Sawai Man Singh Medical College,*

Jaipur: \$3,575 to visit medical centres in the U.S.A. to observe methods of medical education and medical school and hospital administration; *Dr. V. S. Mangalik, Head of the Department of Pathology and Dean of the Faculty of Medicine, Lucknow Medical College*: \$3,525 to observe modern trends in medical education in Lebanon, the U.S.A. and Canada; *Dr. B. C. Bose, Professor of Pharmacology, Mahatma Gandhi Memorial Medical College, Indore*: \$3,500 to observe recent developments in the U.S.A. in pharmacology and in medical education and administration; *Indian Council of Medical Research*: \$3,500 for purchase of equipment to the G. S. Medical College, Bombay, for establishment of an experimental surgery unit under Dr. P. K. Sen, and \$2,000 for purchase of equipment for pharmacological research to one of the Medical Colleges in Madras for the use of Dr. M. N. Guruswami; *Dr. D. Narayan, Professor of Anatomy, Lucknow Medical College*: \$3,472 to observe modern trends in medical education and in anatomy research in the U.S.A. and England.

PEST INFESTATION RESEARCH AT SLOUGH

Pest Infestation Research, 1952, published recently* describes current research at the Pest Infestation Laboratory, D.S.I.R., at Slough. The laboratory is concerned mainly with the control of those insect pests which still destroy enormous quantities of the world's supply of cereal and other foodstuffs in store after harvest.

A new technique has been developed for assessing the potency of pyrethrins compared with a standard. It had been noted several years ago that flour beetles lost weight when treated with pyrethrins. This fact has now been put to use. Simply weighing a batch of beetles before and after exposure gives an accurate measure of the pyrethrin under test. The

method saves time, and eliminates the tedious work of examining and classifying each insect in a batch, as was necessary formerly. It is possible that the method will also work for other insecticides.

In the biochemistry section of the Report, special attention is given to the radioactive tracer techniques for the study of the mode of action of insecticides, in other words, how insecticides work inside the insect. Such knowledge is of the greatest importance when insects become resistant to insecticides, as house flies are becoming resistant to DDT in many parts of the world. It has been possible to show, for example, that resistant flies are able to decompose DDT in their bodies to a harmless form, an ability not shared by ordinary susceptible flies.

* Published by H.M.S.O., London, for the D.S.I.R., England, Price 2s. 1½d. by post.

NUTRITIVE VALUE OF VANASPATI

A REPORT of the work done under the auspices of the Vanaspati Research Planning Committee of the Ministry of Food, Government of India, and the Vanaspati Research Advisory Committee of the Council of Scientific and Industrial Research, has been recently issued.* A major part of this Report—Part I, covering in fact 180 pages in all,—deals with the work done under the Ministry of Food. In Part II is given an account of the work sponsored by the Council of Scientific and Industrial Research.

Part I is divided into six sections and contains in detail the results of experiments conducted according to an agreed plan, in five different laboratories in India. The results have been subjected to careful statistical analysis, a detailed account of which covers 63 pages of the report.

The origin of these scientific investigations is interesting. It lies in the undue and untimely publicity given to the results of certain incomplete investigations with the result that those who were opposed to the expansion of hydrogenated oil industry found what they believed to be scientific reasons for condemning the product as harmful to human health. A few social organizations took a hand in the campaign against "Vanaspati" without getting any authoritative scientific opinion on the matter and helped to create doubt and confusion in the minds of the consumers. The furore against vanaspati reached such a stage of intensity that the Government of India considered it necessary to step in and to order a careful scientific investigation under the auspices of their Ministry of Food.

The investigations on hydrogenated oils were undertaken, as mentioned before, in five different institutions, and included extensive experimentation on laboratory animals and on human beings as well. The work took three years to complete and the opinion of the Committee based on the conclusions drawn from experimental work are best quoted in full from the report.

"Feeding experiments with poor rice diets carried out on rats as well as on human subjects at different centres of research have not shown vanaspati of melting point 37° C. to have any deleterious effect as compared with raw and

refined groundnut oil. It appears that vanaspati of melting point 41° C. is absorbed to a lesser extent than raw groundnut oil and that it may have an adverse effect on calcium utilization, although definite conclusions cannot be drawn from the limited series of experiments on calcium metabolism. As regards comparative nutritive values of (1) pure ghee, (2) raw groundnut oil, (3) refined groundnut oil, (4) vanaspati of melting point 37° C., and (5) vanaspati of melting point 41° C., the balance of experimental evidence places ghee as the best; raw groundnut oil, refined groundnut oil and vanaspati of melting point 37° C. fall into one group and are next best to pure ghee; vanaspati of melting point 41° C. comes third in nutritive value."

The results were in no way different from those which had been reached much earlier by workers abroad. Even in India there was sufficient evidence obtained by a few scientific workers that vanaspati was harmless and that in its nutritive value it resembled the edible vegetable oils from which it was made. There was thus no need for this investigation, but owing to peculiar conditions arising out of the vanaspati controversy, the Government had to spend about Rs. 2,14,120 to prove an already proven fact.

Scientists in this country should draw a moral from this episode. They ought to be very careful when giving publicity to their results. Recent events, however, show that the lesson has not been learnt and that publicity is still valued by some more than scientific veracity. It is a sorry state of affairs and sooner it is mended the better.

A close scrutiny of the report leaves one with the impression that some of the investigations mentioned therein were unnecessary. The fact that they were undertaken contributed to the delay which occurred in completing the programme of work. In one particular investigation, certain peculiar results have been obtained, namely, the bone (femur) ash figures given on pp. 29, 38 and 44. They appear to be inordinately high, particularly those given for poor rice diets. The bone ash of rats fed adequate diets has been found to be 62 per cent. on an average; hence the observations that on poor rice diets—which are known to be deficient in calcium—higher bone ash figures were obtained makes one feel that there is something wrong somewhere.

The investigations sponsored by the Council of Scientific and Industrial Research are in a

* "Investigations on the Composition and Nutritive Value of Vanaspati."—Report issued by the Council of Scientific and Industrial Research, New Delhi, 1952.

different category. They were designed to cover a very wide field of basic and applied research in oils and fats. This will be evident from the list of problems that were taken up for investigation at the outset as detailed on p. 184. Work on some of these has been completed and fresh

problems have been undertaken. As with all researches, those on oils and fats will continue and it is expected that these will make valuable contributions to our knowledge in this particular field.

V. N. PATWARDHAN.

SOME OBSERVATIONS ON *GNETUM ULA* BRONGN. FOUND ON THE WESTERN GHATS

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GNETUM is the only gymnosperm found in the northern parts of the Western Ghats. This genus shows many interesting features resembling both Angiosperms and Gymnosperms. No work appears to have been done so far on any of the Indian species of *Gnetum* and it was thought worthwhile to study some of the important stages such as sporogenesis, male and female gametophytes, the process of fertilization and the development of the fertilized egg up to the embryo formation in one species, viz., *G. ula*.

Following are the important observations made :

(1) The microspores are arranged in a tetrad. The young microspore liberated from the mother cell has dense cytoplasm, a large nucleus with nucleolus and prominent chromatin, and a very thin wall. The first division of the nucleus results in the formation of two cells, one of which is much smaller than the other. The larger nucleus soon divides into two nuclei approximately similar in size. One of these stains feebly and is the tube nucleus while the other—rather deeply stained—is the generative nucleus. This generative nucleus is seen surrounded by a layer of cytoplasm. It is at this stage the pollen grains are shed. They show a spiny exine, a small prothallial cell, a tube nucleus and a generative cell. The further development of the gametophyte was studied both in sections of ovules and in cultures. The pollen grains germinate on the nucellus and not in the micropyle. The exine ruptures and is thrown off. The intine gives rise to the pollen tube which penetrates the papillate cells of the nucellus (Fig. 1). The pollen tubes pass through the intercellular spaces of the nucellus and many such pollen tubes have been observed in a single ovule. The small prothallial cell remains behind in the grain while the pollen tube nucleus enters the tube (Fig. 1). The generative cell soon follows and divides to form two cells which

are the male gametes (Figs. 2, 3). This division of the generative cell was seen a little away from the end of the pollen tube which was quite near the embryo-sac cell. In cultures made in 4 per cent. sugar solution, the last division was seen after about a week.

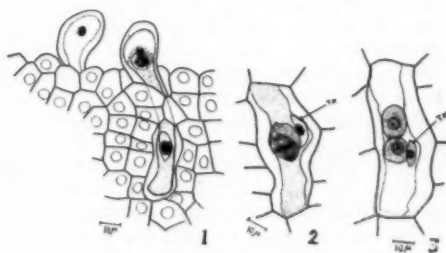


Fig. 1. L. S. of the ovule showing papillate cells of the nucellus with two pollen tubes. Figs. 2 and 3. Showing the division of the generative cell, in the pollen tube.

(2) Several radially elongated cells directly situated below the nucellar epidermis constitute the archesporium. The archesporial cells divide to form the primary parietal cells and primary sporogenous cells. The increase in the number of the parietal cells takes place by the division of the parietal cells as well as the epidermal cells. As many as twelve megaspore mother cells are seen in an ovule (Fig. 4). Out of these, generally one or two or occasionally three mother cells remain functional and undergo further development. The rest degenerate. Ultimately, only one embryo sac develops while others gradually die out. The embryo-sac from the observations made appears to be monosporic. The functional megaspore at an early stage of development shows two vacuoles on either side at the two nucleate stage—the two nuclei being in the centre (Fig. 5). These two nuclei then move towards the two poles of the young elongated embryo sac cell and large vacuole is developed in the centre (Fig. 6).

These nuclei further divide to form a large number of nuclei of the embryo sac cell. The mature embryo sac cell is an inverted flask-shaped body with a long and narrow neck. The number of nuclei in this sac is very large—exceeding a thousand. The actual number counted is 634 out of which some were in prophase and some in metaphase stage. The egg nucleus is

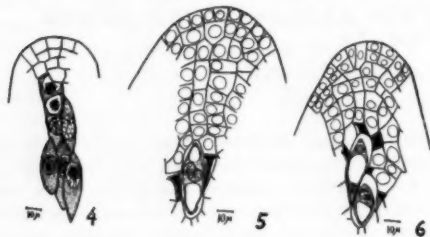
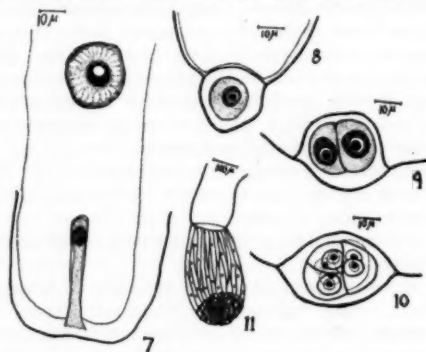


Fig. 4. L. S. of the ovule showing a few megaspore mother cells. Fig. 5. L. S. of the ovule showing embryo sac cell with two nuclei in the centre and vacuoles towards the poles. Fig. 6. L. S. of the ovule showing embryo sac cell with vacuole in the centre and the two nuclei at the two poles.

not prominently differentiated. It may be pointed out that according to Fagerlind,¹ the embryo sac cell in *Gnetum gnemon ovalifolia* is tetrasporic. All the megaspore mother cells show at the four-nucleate stage four nuclei in the centre with vacuoles towards the periphery. At the two-nucleate stage and even before the formation of four-nucleate condition no vacuoles were seen developed. The observations made by us in *Gnetum ula* Brongn., as can be seen from the above description, appear to be quite different.

(3) Before the process of fertilization, the endosperm tissue begins to be differentiated. Cell-walls are laid down in the lower part of the embryo sac, each cell enclosing many nuclei. Walls are also laid down in the upper part—particularly towards the periphery—with the result that a large space with many free nuclei is seen in the centre. At this stage, the egg nucleus with a dense mass of cytoplasm and a male gamete nearby is observed enclosed in a wall. The nuclei fuse and a prominent fertilized egg is observed. It may be pointed out that in some ovules more than one oospore were observed. The oospore nucleus divides to form two cells. These further divide and give rise to an irregular multicellular structure from which are formed a large number of suspensor

tubes which ultimately penetrate the endosperm tissue. The number of the suspensors varies from a few to more than a dozen. Each suspensor has a single nucleus and dense mass of cytoplasm towards the tip. The suspensors grow together like a long, coiled structure and often measure upto 7 cm. The nucleus of the suspensor tube divides to form two nuclei, one of which remains in the suspensor, while the second is cut off to form a small cell at the tip (Fig. 7). This cell is gradually pushed out and finally is separated from the suspensor protoplasm, but remains within the wall of the suspensor (Fig. 8). It divides vertically into two (Fig. 9), and then into four cells. These four cells divide transversely (Fig. 10). Further



Figs. 7 to 11. Showing early stages of development of an embryo.

divisions take place rather irregularly. The cells towards the suspensor become elongated and form a multicellular secondary suspensor, while the cells towards the tip develop into the embryo proper. The secondary multicellular suspensor is seen attached to the end of the primary suspensor tube (Fig. 11). In the beginning, two cotyledons surrounding a conical projection are seen differentiated at the apex. A little later, the root initial is also differentiated internally towards the suspensor. The feeder soon develops as a lateral outgrowth from the hypocotyle region. Feeder is flat in the beginning, but soon assumes a cylindrical form. To start with, many embryos are seen developing, but ultimately, only one attains maturity.

1. Fagerlind, F., "Bau und Entwicklung der *Gnetum* Gametophyten," *Kungl Svenska Vetenskapsakademiens Handlingar*, 1941, Tredje Serien. Band 19, No. 8.

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BETTER RESOLUTION BY USING SUITABLE APERTURES

WILLIAMS¹ has suggested the use of a suitable aperture with Lummer Gehrcke Plate for improvement in resolution at the expense of slight loss of intensity. He made use of the fact that resolution, obtained with N beams of equal intensity is greater than that obtained with N beams of slowly diminishing intensity. The nearer the beams are to equality, the greater is the resolution. Williams proposed placing a trapezium-shaped aperture over the plate-surface for the purpose. The increase in width of the emergent beam compensates for the loss in intensity due to successive reflections and absorptions in the plate.

The emergent beam system² in Lummer Gehrcke plate consists of $N (= 1/2t \tan \tau)$ interfering beams of intensities $I_0 a^{2(N-1)}$, $I_0 a^{2(N-2)}$, $I_0 a^2$ and I_0 ($a = \text{Re}^{-\frac{1}{2} \tan \tau}$) emerging from points on the plate with a constant separation $d (= 2t \tan \tau)$. In order to obtain maximum possible resolution from the instrument, we should make the intensities of all the beams equal by placing a suitable aperture over the plate-surface. The condition for this is that the ratio of the widths of the aperture at any two points separated by a distance d is the same namely, a^2 . The condition is not fulfilled by Williams' trapezium-shaped aperture, as is easily seen.

The author suggests the use of two types of apertures to achieve this as shown in Figs. 1

and 2. Fig. 1 is self-explanatory. The equation to the aperture with curved boundary



FIG. 1

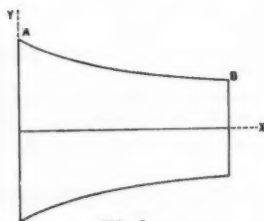


FIG. 2

(shown in Fig. 2) is $y = f(x)$, where $f(x)$ is the solution of the equation:

$$\frac{f(x+d/2)}{f(x-d/2)} = a^2$$

The solution, satisfying the boundary condition $y = b/2$ at $x = 0$, is:

$$y = (b/2) a^{2x/d} \quad (1)$$

The intensity patterns without and with the suggested apertures are given by:

$$I = \frac{I_0 \{ (1-a^N)^2 + 4a^N \sin^2(N\beta) \}}{\{(1-a)^2 + 4a \sin^2 \beta\}} \quad (2)$$

and

$$I' = \frac{I_0 a^{2(N-1)} \sin^2(N\beta)}{\sin^2 \beta} \quad (3)$$

The principal maxima in the two cases have the intensities:

$$I_{max} = \frac{I_0 (1-a^N)^2}{(1-a)^2} \quad (4)$$

and

$$I'_{max} = I_0 a^{2(N-1)} N^2 \quad (5)$$

The resolving powers in the two cases are:

$$R = N_0 R_0 \quad (6)$$

and

$$R' = N R_0 \quad (7)$$

where $R_0 = \{m - (2t/\cos r) (d\mu/d\lambda)\}$, m being the order of the fringe. Curves giving the values of N_0 for various values of N and a have been given by Candler.³

N_0 is always less than N and it is clear that the use of an aperture of the above shape increases the resolving power.

Recently, Sodha⁴ has shown that the emergent beam system from a transmission echelon is similar to that from a Lummer Gehreke Plate

except that $a^2 = e^{-kt}$, t being the height of a step and k the absorption coefficient for intensity. So, in this case also similar apertures will be useful. Equations (4) to (7) will be true except that $R_0 = (m - t d\mu/d\lambda)$, where m is the order of the fringe.

The author acknowledges thanks to Dr. K. Majumdar, Dr. Y. P. Varshni, Dr. D. Sharma and Prof. B. K. Agarwal for their kind interest in the investigation.

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Allahabad, March 10, 1953.

1. Williams, *Personal Communication in High Resolution Spectroscopy*, 1947 (Methuen & Co., London) p. 209.
2. Sodha, *Jour. Sc. Ind. Res.*, 1952, **11B**, 395.
3. Candler, *Modern Interferometers* (Hilger & Watts, London), 1949, p. 339.
4. Sodha, *Sc. and Cult.*, 1953, **18**, 489.

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STUDIES OF SAND MOVEMENT ACROSS THE WALT AIR BEACH

In connection with the extensive Oceanographic Programme now being carried on by the Andhra University, studies of sand movement on the Waltair Beach have been in progress since December 1952. The preliminary results of the study presented here deal with the movement of sand in the intertidal zone.

With data obtained from repeated measurements of profiles of the beach, the concentration of black sand, compaction of the sand, waves, current and especially tide range, several comparisons were made and cycles established. The foreshore is usually eroded during spring tides and the eroded sand is deposited on the lower foreshore and offshore. The cycle in sand level is completed when, in periods of neap tide, the sand is returned up the beach to approximately its former level. The main difference in environmental conditions, aside from the height of water during spring and neap tide are (1) the relative time that any vertical level of beach is washed by the waves, and (2) the character of waves caused by the difference in water depth. By calculating the washed zones it was found that spring tides produce two zones of long duration wash, while neap tides produce only one. This is believed to be a major factor in the sand movement from one level to another on the beach.

The wave energy at low tides is believed to be dissipated over the long shallow offshore

area, whereas at high tide, the energy is expended at a local zone high on the foreshore. Thus, the sand movements in various zones of the beach are largely related to the tide range.

The compaction of sand on the foreshore just above mean tide level during periods of deposition is less than it is during periods of erosion. Further, the heavy black sand concentrates appear to be moved on the beach in cycles related to the sand level. Its appearance is probably due to the panning action or erosional concentration of waves when the beach undergoes major cuts. The heaviest concentration of the black sand is on the upper foreshore.

A detailed paper embodying these results is under publication in the Memoirs of the Andhra University—Oceanography, Part I.

Andhra University,
Waltair, June 5, 1953.

E. C. LA FOND.
R. PRASADA RAO.

EXTRACTIVES FROM SOUTH ARCOT LIGNITE

SOUTH ARCOT lignite¹ yields montan wax, an ester wax extracted by solvents from certain types of lignite. Chandra² extracted a sample of "Cuddalore lignite" with benzene, petroleum and chloroform and his reported yields of extractives are low. In the present investigation, ten samples of South Arcot lignite were extracted with benzene and xylene and the yield of raw wax (which is generally a mixture of wax and resin) compared with yields from foreign lignites.

Every sample of lignite is first air-dried and about 20-30 g. of the material were extracted with the solvent in a soxhlet apparatus until the solvent in contact with the lignite was colourless. The solvent was distilled off and the yield of wax determined. A composite sample of the wax material was used for the determination of the melting point and the ash content.

Table I gives the yield of raw wax.

The data indicate that the yield of extractives are higher with xylene than with benzene and is dependent on the nature of the lignite, it being higher where the volatile matter in the lignite is higher.

The wax was a hard and brittle material with a dark brown colour. It was partially soluble in alcohol and ether. The melting point of benzene extractives was 83-84° C. and that of xylene extractives, 81-82° C. The ash content of the former was 0.25 per cent., while that of the latter, 0.23 per cent.

The yield of benzene extractive from South Arcot lignite (percentage by weight of mois-

TABLE I
YIELD OF EXTRACTIVES
Summary of results on ten samples of South Arcot lignite

| Vol. matter | Fixed carbon | Extractives with benzene | | | Extractives with xylene | | |
|-------------|--------------|--|----------------|----------------|-------------------------|----------------|----------------|
| | | percentage (moisture and ash-free basis) | percentage (1) | percentage (2) | percentage (3) | percentage (1) | percentage (2) |
| 52.3 | 30.5 | 0.99 | 1.30 | 1.41 | 1.95 | 2.32 | 2.49 |
| to | to | to | to | to | to | to | to |
| 60.5 | 47.7 | 9.95 | 10.88 | 11.36 | 11.14 | 12.17 | 12.72 |

1. By weight of lignite. 2. By weight of moisture free lignite. 3. By weight of moisture and ash-free lignite.

ture-free lignite) compares favourably with yields from Devon lignite,³ 3.0 to 5.0 per cent., Texas lignite,⁴ 1.5 to 2.4 per cent., North Dakota lignite,⁴ 1.2 to 1.6 per cent., California lignite,⁴ 6.6 to 7.1 per cent. and German lignite,⁵ 10 to 15 per cent.

Not all samples of South Arcot lignite give high wax yields. A selection based upon the analysis of the raw lignite would be necessary for obtaining the best lignites for wax extraction.

We thank the Government of Madras for permitting the publication of these results, and Dr. Paul R. Eyrich and Mr. H. K. Ghose for their interest in the progress of this work.

Lignite Investigation Lab., C. V. S. RATNAM.
Govt. of Madras, Neyveli, S. VEERARAGHAVAN.
June 30, 1953.

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AMMONIUM SULPHATE AS A FLUX FOR ILMENITE

AMMONIUM SULPHATE, when heated to its melting point, 150° C., decomposes slowly upto 340° C. into ammonia and ammonium bisulphate. On fusion with any basic oxide, it loses ammonia in common with other ammonium salts, transferring its acid part to the new base. The

formation of the acid sulphate by heating the neutral salt indicated, therefore, that it may be used in place of sulphuric acid or sodium and potassium bisulphates to open up ilmenite and other ores.

Ilmenite sand from Travancore was finely crushed and levigated. The levigated ore was mixed with varying quantities of $(\text{NH}_4)_2\text{SO}_4$ and Na_2SO_4 and the mixture was ignited in a silica crucible at about $300-340^\circ\text{C}$, till the evolution of NH_3 was complete and the fused mass started giving white fumes. The cooled mass was extracted with acidulated water (H_2SO_4) and filtered. The filtrate was preserved and the residue was ignited to constant weight.

The difference in the weight of the sample and its residue was taken as a measure of the extent of the reaction.

The following table gives the quantitative details of the experiment:—

| Expt. | Ilmenite | Ammonium sulphate | Sodium sulphate | Residue | Extraction % | Ore : $(\text{NH}_4)_2\text{SO}_4$ |
|-------|----------|-------------------|-----------------|---------|--------------|------------------------------------|
| 1 | 0.1530 | 0.4 | 2.5 | 0.0872 | 40.3 | 1 : 3 |
| 2 | 0.1466 | 0.4 | 2.5 | 0.0894 | 40 | |
| 3 | 0.1592 | 0.4 | 2.5 | 0.1026 | 36 | |
| 4 | 0.1472 | 0.6 | 2.5 | 0.0526 | 64 | 1 : 4.5 |
| 5 | 0.1453 | 0.6 | 2.5 | 0.0480 | 67 | |
| 6 | 0.1502 | 0.8 | 2.5 | 0.0270 | 80.2 | |
| 7 | 0.1528 | 0.8 | 2.5 | 0.0310 | 80 | 1 : 6 |
| 8 | 0.2522 | 1.6 | 3.5 | 0.0408 | 84 | |

Higher proportions of ammonium sulphate did not yield better results. Extension of these observations to other ores is under investigation. Grateful thanks are due to Prof. S. S. Joshi for his advice and guidance.

Banaras Hindu University, D. K. PATWARDHAN.
May 1, 1953. G. S. DESHMUKH.

RAPID ESTIMATION OF YIELD AND IODINE VALUE OF OIL IN SMALL SAMPLES OF OILSEEDS

IN continuation of earlier studies,¹ a method has now been worked out to determine both yield and iodine value of an oil with 0.3 to 0.5 g. of seeds in about 1.5 to 2 hours, using carbon tetrachloride as solvent. The procedure adopted is as follows:—The weighed sample (0.3–0.5 g.) is ground with 2–3 g. of anhydrous sodium sulphate and 2 g. glass powder (pyrex glass, washed with hydrochloric acid) in a mor-

tar, transferred to a 50 ml. Erlenmeyer flask with 8–10 ml. of carbon tetrachloride, refluxed for 3 to 4 minutes and after cooling, filtered through a sintered glass funnel into a 25 ml. graduated flask. The flask and residue are washed with small amounts of the solvent till the total filtrate is about 20–22 ml. This is then made up to volume. 5 ml. aliquots are evaporated in crucibles or flat dishes in a vacuum oven at 100°C . for one hour or till constant weight is reached, and from the weight of the residue the oil content is calculated.

To determine the iodine value of the oil extracted, 5 ml. aliquots of the solution (weight of oil in 5 ml. of the solution determined as aforesaid), are pipetted out into iodine value flasks, 10 ml. of Hanus' solution added and the determination conducted as usual, the only alteration introduced being the use of N/20 instead of N/10 sodium thiosulphate solution.

Experiments were conducted with linseed (4 different varieties), safflower seed, *Brassica campestris* seed, tobacco seed, poppy seed, groundnut, mustard seed and til seed. In the case of linseed, the time of reaction for iodine value determination had to be increased to two hours; in all other cases, the usual half-hour period was found sufficient.

In all the above cases, the yield of oil using carbon tetrachloride as solvent was the same as when benzene was used. The iodine value of the oil determined according to the present method agreed with that determined by conventional procedures on the oil expressed from the seeds to within one unit. Fuller details will be published elsewhere.

Thanks are due to the Indian Central Oil Seeds Committee for enabling one of us (A. S. S.) to take part in the investigations, and for permission to publish the results.

Indian Agric. Res. Inst.,
New Delhi,
March 15, 1953.

A. S. SETHI.
A. R. S. KARTHA.
K. C. GULATI.

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ORBITOIDS FROM THE CRETACEOUS ROCKS NEAR ARIYALUR (S. INDIA)

SINCE reporting recently (*Current Science*, March 1953), the occurrence of a rich foraminiferal fauna dominated by the Orbitoids in some of the sandstones near Ariyalur, several sections of these rocks have now been looked into for the study of their foraminiferal contents, especially the Orbitoids. From this general and

preliminary examination, it would appear that there are four types of Orbitoids commonly found here. The following short notes, with the illustrative microphotographs (Figs. 1-4), will serve to give a general idea of each of these types.

conch is not clearly preserved; the nature and arrangement of the lateral chambers very clearly seen; the form appears to be slightly asymmetrical. Length: 2.496 mm. Breadth: 0.720 mm. The general shape of the form is quite distinct.

Fig. 3 shows a tangential section; the com-

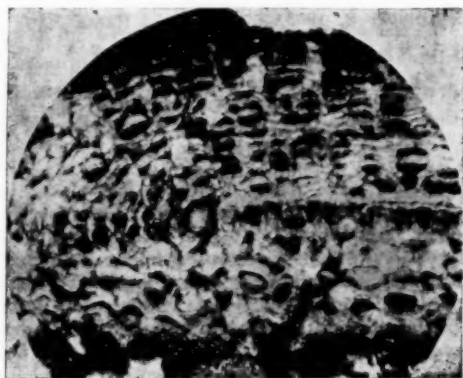


FIG. 1, $\times 64$

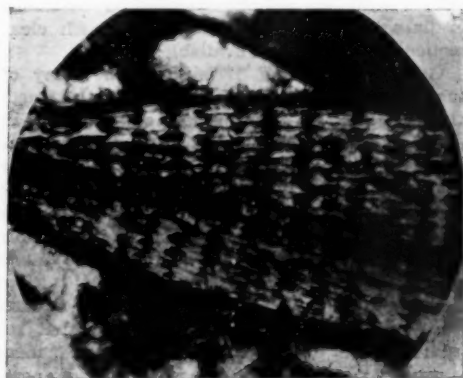


FIG. 3, $\times 80$

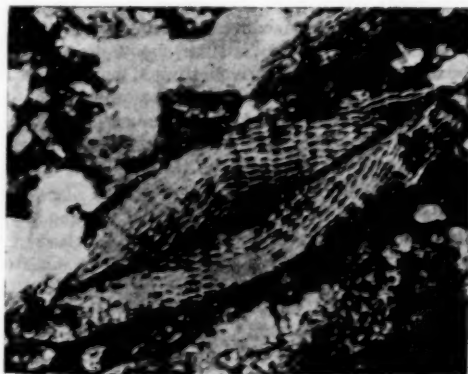


FIG. 2, $\times 30$



FIG. 4, $\times 90$

Fig. 1 shows an oblique tangential section; the complete form is seen in the slide, but only a part has been shown in the photograph. Length: 2.400 mm. Breadth: 0.720 mm. The form is tapering only very slightly, the breadth being practically the same throughout. Nature and arrangement of the chambers clearly seen; but the orientation of the section in the lower half is not the same as in the upper. Chamber roofs cribriform; stoloniferous apertures noticed.

Fig. 2 shows a fine section which appears to be truly axial; but the region of the nucleo-

plete form (seen in the slide) is elongated and gradually tapering. Length: 2.784 mm. Breadth: 0.480 mm. Equatorial chamber walls thick and prominent; outline of chambers squarish, slightly oblong, or diamond-shaped. Lateral chambers in tiers, 9 or 10 in the centre, and reduced to 3 or 4 towards the periphery.

Fig. 4. A true vertical section showing the nucleoconch. The full form is seen in the slide, and is very well preserved. Length 2.016 mm. Breadth: 0.538 mm. Form slightly asymmetrical, being more convex on one side than on the other. The most interesting feature is the

bilocular nucleococonch with two large sub-equal chambers separated by a straight wall. The two chambers of the nucleococonch are enclosed by a thick wall, well seen in the photograph. The outlines of the two chambers are well defined and sharp. This type of nucleococonch suggests a lepidocycline(?) feature. An equatorial section with the chambers would be necessary in fixing up this identity; but no such clear section has yet been available.

Generally speaking, it is seen that many of the slides are full of Orbitoids; and though the sections are often partial and incomplete, some show quite clearly the shape and arrangement of the chambers, structure of the chamber walls, nature of the stolon system, etc. These have been compared with the other Cretaceous Orbitoids already described from India, notably by Vredenburg (1908), Douville (1916), and more recently by S. R. N. Rao (1941) from this very area. None of the forms now under study has been named as yet; for that requires more elaborate comparisons and measurements based on the study of properly oriented sections, especially equatorial. But even at this stage it seems reasonable to indicate that many of the forms found here appear to be new, at least so far as India is concerned in the sense that they have not been noticed before.

In addition to these Orbitoids, a number of other Foraminifers are also represented in these rocks; particularly striking are some forms which look like true Nummulites, but very small; and others which are probably Ammibaculites (?). Siderolites, is also there.* It is specially interesting to note that in a general survey of this entire foraminiferal assemblage, we see now and again indications of a distinct early Tertiary (Paleocene?) touch. *Prima facie*, these beds would of course be considered, from their position in the field, as part of the Upper Ariyalurs, Maastrichtian in age; and the general nature of the Orbitoids would seem to support this view; but what the entire assemblage would ultimately mean, on fuller study, remains to be seen. The whole material is certainly of outstanding interest, and it will naturally take some time before it is all properly worked out.

This is being done and a fuller paper will soon be published elsewhere.

Bangalore,

L. RAMA RAO.

July 22, 1953.

*Since writing the above, more sections of these rocks have been prepared and examined; and it is seen that some of them reveal the

abundant occurrence of *Siderolites* most beautifully preserved. In view of the fact that *Siderolites* is such an interesting genus, and we know at present so little of this form in India, the present find promises to be specially valuable. A note on this subject will be published shortly.

September 3, 1953.

L. RAMA RAO.

ARTIFICIAL PRODUCTION OF TETRAPLOIDS IN *RICINUS* *COMMUNIS* LINN.

AN effort was made to induce polyploidy in castor (*Ricinus communis* Linn.) at Government Agricultural College, Kanpur, during 1949-50. Solutions of colchicine, having concentrations ranging from 0.1-0.5 per cent. were used for inducing polyploids. Both apical meristematic region of plants and germinating seeds were tried.

It was found that 0.3 per cent. of colchicine solution gives successful results in induction of polyploid in the apical meristem and germinating seeds. For both the cases, there was no effect with lesser concentrations, while with greater concentrations, all the shoots died. The tetraploid so obtained was studied with diploid in relation to number of chromosomes, size of pollens, stomata, cotyledonary leaves and seeds. The arrangement of the chromosomes is presented in Plate I.



Anaphase II Polar view showing 40 distribution, Polyploid.

Metaphase I Polar view showing 10 distribution, Diploid.

During March and April 1950, between 9 and 10 a.m., male buds were fixed in acetic alcohol (1:3) and then changed to 70 per cent. alcohol after 24 hours. Stamens were smeared on slides

in acetocarmine and then the preparations were made permanent for cytological studies by McClintock's method. Pollens were also stained by acetocarmine in a grooved slide and made permanent as above. The lower epidermis of polyploid and diploid leaves were teased, stained with fast green and made permanent for stomatal studies.

The author is very grateful to Prof. K. N. Kaul for valuable guidance in the work.

Agricultural Officer, ANUBHAV NARAIN,
Gulshan Alam, Bhopal,
April 1953.

INFLUENCE OF FORMIC ACID ON THE HYDROLYSIS OF TISSUE (LIVER) PROTEINS

THE present methods of hydrolysing the tissue proteins with concentrated acid or alkali suffer from two handicaps: (1) They are time-consuming, often requiring 6-24 hours of refluxing with concentrated acid or alkali, and (2) they cause a loss of some of the amino acids due to destruction or deamination.^{4,6,9} Other acids² including formic acid^{3,7} have also been advocated for the hydrolysis of proteins, but none of these had any definitely established advantage except possibly when it is desired to isolate a particular amino acid. Considerations of structural factors, such as the steric hindrance to the approach of water molecules preparatory to hydrolysis of peptide bond⁵ and the knowledge that formic acid transforms the folded polypeptide chains into the easily accessible extended peptide chains¹ led us to study the rate of hydrolysis of tissue proteins with HCl, after the tissue had been treated with formic acid. It is this aspect of the investigation that is being reported here.

Fresh liver tissue obtained from slaughter house were used in all the experiments reported here. For every gramme of the liver tissue taken, 5 ml. of 85 per cent. formic acid is added and heated to boiling. The tissue goes into solution immediately after boiling. The rates of hydrolysis of this formic-acid-treated tissue material is then studied using 6 N, 4 N and 2 N hydrochloric acid. Samples were withdrawn from the refluxion mixture at 15 minutes interval, cooled to room temperature and the amino acids liberated determined by the formol titration technique.⁸ Qualitative biuret tests were also carried out on each of the samples to determine the presence of peptide bonds in the sample. The hydrolysis was continued till

the biuret test became negative and the amino acid titre remained constant. The results with 2 N HCl are given in Fig. 1. Similar curves were obtained with 6 N and 4 N HCl. The hydrolysis time for the formic-acid-treated tissue with 6 N HCl was 45 minutes whereas that of untreated tissue was 60 minutes. The corresponding figures with 4 N HCl were 75 and 105 minutes respectively.

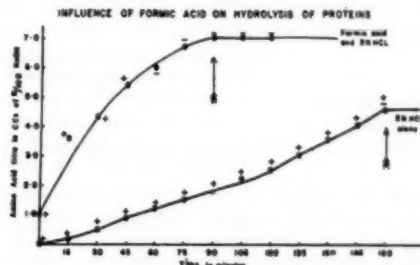


FIG. 1. Progress of hydrolysis with 2 N HCl
+ Biuret test positive — Biuret test negative

In one experiment, the progress of hydrolytic effect of formic acid alone, without the subsequent addition of HCl was studied. The tissue proteins remained practically unaffected even after two hours of refluxing.

To test the efficacy of the method, various amino acids, such as glycine, tryptophane, glutamic acid, cystine, leucine, lysine and phenylalanine were subjected to formic acid treatment followed by 1 hour refluxing with 6 N, 4 N and 2 N HCl. Pure amino acids were used for this purpose and amount of amino acid remaining in the hydrolysate after refluxing was determined by the formol titration method. The proportion of formic acid and the strengths of acid used was the same as used in the hydrolysis of tissue proteins. The recoveries of individual amino acids are given in Table I.

The influence of formic acid on the hydrolysis of different proteins, such as casein and gelatin was also studied. But the rates of hydrolysis of casein and gelatin were not in any way altered by the treatment with formic acid prior to acid hydrolysis.

It was found that though formic acid treatment prior to acid hydrolysis did not in any way influence the rate of hydrolysis of casein and gelatin, it did reduce the hydrolysis time considerably when the liver tissue was treated with formic acid prior to hydrochloric acid hydrolysis. The results were very much more

marked with 2 N HCl. In this case, the liver hydrolysate showed a positive biuret test three hours after refluxing with 2 N HCl alone, whereas the formic acid treated tissue was completely hydrolysed in 90 minutes time. These results show very clearly that formic acid treatment prior to acid hydrolysis does facilitate hydrolysis.

TABLE I

Recovery of amino acids subjected to formic acid-hydrochloric acid hydrolysis

| Name of amino acids | Percentage recovery of amino acids after one hour refluxing with formic acid and HCl | | |
|---------------------|--|-----------------------|-----------------------|
| | Formic acid + 6 N HCl | Formic acid + 4 N HCl | Formic acid + 4 N HCl |
| Glycine | 98.9 | 99.0 | 99.0 |
| Tryptophane | 98.5 | 98.5 | 98.5 |
| Glutamic acid | 94.0 | 94.0 | 94.0 |
| Cystine | 95.9 | 95.9 | 95.9 |
| Leucine | 98.0 | 98.0 | 98.0 |
| Lysine | 99.7 | 99.7 | 99.7 |
| Phenylalanine | 99.0 | 99.0 | 99.0 |

The new procedure has, therefore, a double advantage. It not only curtails the time of hydrolysis, but also protects the amino acids, which are normally destroyed during the acid hydrolysis, due to oxidative degradations. This may probably be due to reducing properties of formic acid by virtue of its CHO group in the molecule.

The authors wish to thank Dr. V. R. Khanolkar for his kind interest in the work.

Indian Cancer Res.

S. U. GURNANI.

Centre,

M. B. SAHASRABUDHE.

Parel, Bombay,

May 26, 1953.

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ASSOCIATION OF CHANGE IN PHYLLOTAXY WITH THE OCCURRENCE OF TRICOTYLY IN ANTIRRHINUM MAJUS AND ZINNIA PERUVIANA

TRICOTYLEDONOUS seedlings occasionally occur in nurseries of dicot plants. Tricotyly seems to be associated with the change of phyllotaxy (i.e., the orientation of the leaves on the stem) as observed in two species of ornamental plants.

(1) *Antirrhinum majus* (Family—Scrophulariaceae.)

Snapdragon, as it is commonly called, is a floral herb and is renowned as an ornamental plant. Normally (in dicotyledonous seedlings), the leaves are arranged in the main axis in opposite and decussate fashion. But, in this tricotyledonous plant, the leaves were verticillate with three at each node. The internodal length between the dicot and the tricot remained the same. The size and the shape of the leaves did not differ. The height of the tricot plant was nearly the same as that of the dicot plant as the former measured 45.5 cm. and the latter 44.0 cm. The axillary shoots, however, did not show the verticillate arrangement of the leaves, but had the same nature of phyllotaxy as that of the dicot sib.

The inflorescence or the flower was not much different from that of the dicot, but the pollen sterility in the tricot anthers was 90 per cent. No seeds could be obtained by either selfing or reciprocal crossing with the dicot.

(2) *Zinnia peruviana* (Family—Compositae).

It is an annual, floral herb with simple connate leaves arranged in an opposite and decussate manner in the dicot plants. But, in the tricot, the leaves were arranged spirally such that every sixth leaf on the axis was exactly over the first leaf and for reaching the sixth leaf from the first, one has to make two circles round the stem. The angle of divergence, therefore, equals $2/5 \times 360^\circ$, i.e., 144° .¹ It might, however, be noted that the axillary shoots had opposite and decussate leaves like the dicot sib. The main axis of the tricot presented a twisted appearance. Further, the shape of the leaf was affected in the tricot. The leaves were simple and sessile instead of being connate (i.e., the two leaf-bases together encircling the node). The height of the tricot was 53.5 cm. and that of the dicot was 50.0 cm., thus showing no appreciable difference.

In the tricot, 95 per cent. of the pollen grains were sterile and no seeds could be obtained by

either selfing or reciprocal crossing with the dicot.

Central Rice Res. Institute,
Cuttack-4, Orissa,
June 5, 1953.

B. MISRO.

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University Tutorial Press Ltd., 1947, London.

EFFECT OF NITROGENOUS FERTILIZATION ON THE INCIDENCE OF 'BLAST' ON RICE VARIETIES

THE following nine varieties, Co.4, T.141, T.608, GEB.24, T.1145, BAM.5, Co.3, ASD.1, Co.13, were used in a test to see how rice varieties react to blast (foliar infection) under different levels of N fertilization. The experimental unit was 25 seedlings of a variety growing in five pots—at the rate of 5 seedlings per pot, for each level of N tested. N was applied in the form of ammonium sulphate solution when the seedlings were a fortnight old to give approximately 20, 40, 60, 80 and 100 lb. of N per acre. A set of 25 seedlings was left unfertilized to serve as a control in each variety. A week after the application of the fertilizer, the seedlings were infected with a spore suspension of *Piricularia oryzae*. The degree of infection which developed on the seedlings was scored 7 days later according to the standard method used at the Central Rice Research Institute.

The infection scores were analysed statistically and the results are presented in Table I below.

B. Average infection score of each variety under different levels of N fertilization

| Level of N, lb. per acre → | 0 | 20 | 40 | 60 | 80 | 100 | Mean |
|----------------------------|---------|-------|--------|--------|--------|--------|--------|
| Variety | | | | | | | |
| T. 141 | .. 1.92 | 8.64 | 10.30 | 21.20 | 129.60 | 110.60 | 47.04 |
| T. 608 | .. 1.80 | 3.60 | 22.24 | 18.48 | 19.44 | 57.46 | 20.50 |
| CO. 4 | .. 2.28 | 1.76 | 2.02 | 3.10 | 3.64 | 4.60 | 2.90 |
| GEB. 24 | .. 4.44 | 11.66 | 32.52 | 40.48 | 53.28 | 71.52 | 35.65 |
| T. 1145 | .. 3.00 | 7.80 | 36.16 | 38.56 | 57.76 | 65.16 | 34.74 |
| BAM 5 | .. 2.16 | 8.92 | 44.40 | 86.72 | 103.84 | 45.60 | 48.67 |
| CO. 13 | .. 1.06 | 46.32 | 117.20 | 138.58 | 157.00 | 147.84 | 101.48 |
| ASD. 1 | .. 2.84 | 18.42 | 37.68 | 109.04 | 120.58 | 133.28 | 70.31 |
| CO. 3 | .. 1.58 | 23.64 | 38.42 | 79.90 | 50.44 | 47.82 | 40.30 |
| Mean | .. 2.44 | 14.53 | 37.93 | 59.56 | 77.19 | 75.99 | |

S.E. of treatment Mean = 1.97; C.D. = 6.23

S.E. of varietal Mean = 1.97; C.D. = 7.63

S.E. of individual Mean = 6.71; C.D. = 18.68

The varietal and nitrogen treatments as well as the varietal \times N interaction were highly significant. The increase in leaf infection of blast in rice with increase in level of N application varied significantly between varieties. For instance, there was practically no increase in infection in Co.4, over the 6 levels of N, while in Co.13, the amount of infection increased steeply with each increase in level up to 80 lb. The reaction of the other varieties lay between these two extremes. Similar results have been reported for "neck infection" in blast between Co.4 and ADT.10.¹

On account of the differential reaction of varieties to blast under different levels of N fertilization, it is desirable that artificial infection tests are carried out under a standardised

TABLE I
DIFFERENTIAL REACTIONS OF VARIETIES TO BLAST
INCIDENCE UNDER GRADED LEVELS OF
N FERTILIZATION
A. Analysis of variance

| Source | Degrees of freedom | Sum of squares | Mean sum of squares | Fk* |
|------------------------------------|--------------------|----------------|---------------------|--------|
| Nitrogen levels (N) | 5 | 170441.49 | 34088.30 | 151.68 |
| Varities (V) | 8 | 215733.44 | 26966.68 | 119.95 |
| Interaction V \times N | 40 | 113127.16 | 2828.18 | 12.58 |
| Remainder (pots within treatments) | 216 | 48561.02 | 224.82 | |
| Total | 269 | 547863.11 | | |

* Significant at 1% level.

N level, so that any two tests are comparable. For purposes of recommending varieties as 'resistant' for general cultivation, it is suggested that the tests may be conducted at 40 lb. N per acre in India, as this represents the optimum economic level of N for this country and is widely recommended as such. However, in order to pick out the more highly resistant varieties, which may be used as parents in hybridization, it would be useful to have the tests at 100 lb. N per acre.

The author is indebted to Shri K. Ramiah for his keen interest in the study, and to Dr. N. Parthasarathy for his critical suggestions and help in the preparation of the manuscript.

Central Rice Res. Inst., S. Y. PADMANABHAN.
Cuttack, June 6, 1953.

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PHOTOPERIODIC BEHAVIOUR OF CERTAIN VARIETIES OF RICE

THIRTY days' old seedlings of *Oryza sativa* were given short-day treatment of 8 hours' duration (7 a.m. to 3 p.m.) for 20 days. They came to head within 60-80 days after sowing.

(i) With GEB. 24, a variety from Madras (flowering time: 145 days), the following results were obtained (Table I).

TABLE I

| Time of sowing | Mean interval between flowering and sowing | | Photoperiodic response |
|----------------|--|---------|------------------------|
| | Treated | Control | |
| 21-4-52 | 58.0 | 185.0 | 127.0 |
| 26-6-52 | 65.4 | 145.5 | 80.1 |
| 19-7-52 | 67.7 | 106.0 | 38.3 |
| 30-8-52 | 77.3 | 105.4 | 28.1 |

As the date of sowing approaches the normal season of flowering, the margin of response gets narrower and narrower; it gets reduced from 127 days to 28.1 days, i.e., it behaves as a season-bound variety.

When seeds of GEB. 24 were sown on 27-10-1951, the flowering occurred within 150 days, i.e., in both the years, towards the end of March, when the days get longer. It no longer functions as a season-bound variety. From this behaviour, one would perhaps group the variety as a long-day plant. But long-day

treatment did not cause any early flowering and it cannot be strictly called a long-day plant.

Thus, GEB. 24 behaves neither as a typical long-day nor as a typical short-day plant, and may, therefore, be classified into an "intermediate" group.

(ii) Seeds of Baok¹ were sown in 8 pots on 26-12-1952, and five plants were retained in each. Three pots were given short-day treatment of 8 hours daily for 20 days to seedlings of age 14, 21 and 28 days respectively. Another set of three pots of corresponding age was subjected to long-day treatment by exposing throughout the night to 500 watt electric light for 20 days. Two pots were retained as control. The results are indicated in Table II.

TABLE II

| Age of the seedlings in days when treated | Nature of photoperiodic treatment | |
|---|-----------------------------------|--------------------|
| | Short-day treatment | Long-day treatment |
| 14 | 128.5 | 127.3 |
| 21 | 141.0 | 133.3 |
| 28 | 138.2 | 136.7 |
| Control | 144 | .. |

It can be seen that there is response to both short-day and long-day treatment when 14 days' old seedlings were treated. Baok falls into a distinct group of its own. The age of the seedlings at which it is subjected to photoperiod treatment is also important, and this is more clearly illustrated below.

(iii) Two improved strains (T. 90 and T. 1242) procured from the Orissa Agricultural Department did not show any response to the usual photoperiodic treatment afforded to other indica varieties. Both are late winter varieties.

Seeds of T.1242 (flowering time, 122 days), were sown in thirteen pots containing five seedlings each. Treatment of 20 days of 8 hours' duration (7 a.m. to 3 p.m.) was given to the plants at weekly intervals from 0 to 11 weeks.

There was a response (20 days) only when 35 days' old seedlings were treated. Where younger seedlings were treated, the response was negative, perhaps because of the restricted supply of sunlight at early stages of growth and development. It appears as though there is a critical age before which, if photoperiod treatment is given, there is no benefit obtained from such treatment. This critical age may differ with different varieties.

The fact that there is no response to photo-period treatment with seedlings of a particular age should not lead one to believe that the type under consideration is photoperiodically insensitive. The treatment should be tried at various ages of the seedlings before any such conclusions can be drawn.

Central Rice Res. Institute,
Cuttack-4 (Orissa),
June 5, 1953.

B. MISRO.
S. S. MISRA.
A. B. SASTRI.

I. Chandraratna, M. F., *Trop. Agriculturist*, 1952, 108, 4-10.

COLD AGGLUTININS IN GLYCINE SOJA

MANY iso-agglutinins such as anti-A, anti-H, anti-M and others act more strongly at refrigerator temperatures than at body temperature. This effect is even more striking in the case of cold auto-agglutinins which may act in very high titres in the cold but yet be inactive at body temperature.

Recently, the action of agglutinins derived from certain seeds has been extensively studied particularly in relation to human red blood cells.¹ Some seed agglutinins bear a close resemblance to human iso-agglutinins; for example, the agglutinins of *Phaseolus lunatus* give agglutination reactions which are apparently indistinguishable from those of human anti-A sera.²

In order to determine if the action of seed agglutinins was influenced by temperature, as in the case of certain iso-agglutinins and auto-agglutinins, parallel titrations of certain seed extracts were conducted at laboratory (28-32° C.) and refrigerator temperatures (6-10° C.) against human erythrocytes of groups O, A and B. The seeds tested were (a) *Dolichos biflorus* and *Phaseolus lunatus* known² to be absolutely specific for the human hæmagglutinin A, (b) *Vicia faba* and *Lathyrus sativus* which contain non-specific agglutinins,^{2,4} and (c) *Cyamopsis psoralidoides* and *Glycine soja* (soya bean) previously found to be inactive at laboratory temperatures.³

2 per cent. suspensions of fresh unwashed cells were used and extracts were prepared as described by Boyd and Reguera.⁴ Titrations were carried out using the serial two-fold dilutions method. The results are shown in Table I.

The titre of *Dolichos biflorus* was slightly increased in the cold but that of *Phaseolus lunatus* was the same. The A-specificity of these extracts remained unaltered. The titre of the non-specific extracts was not significantly

increased. These four extracts produced more clear-cut agglutination at refrigerator temperatures. *Cyamopsis psoralidoides* remained inactive in the cold but *Glycine soja* was found to contain fairly powerful non-specific cold agglutinins.

TABLE I

Titres of various seed extracts against human erythrocytes at laboratory and refrigerator temperatures

| Species | Laboratory temperature (28°-32° C.) | | | Refrigerator temperature (6°-10° C.) | | |
|--------------------------------|-------------------------------------|----|------|--------------------------------------|-----|------|
| | Cells | O | A B | O | A | B |
| <i>Dolichos biflorus</i> | | 0 | 64* | 0 | 0 | 256 |
| <i>Phaseolus lunatus</i> | | 0 | 2048 | 0 | 0 | 2048 |
| <i>Vicia faba</i> | | 16 | 16 | 16 | 32 | 32 |
| <i>Lathyrus sativus</i> | | 32 | 32 | 32 | 64 | 64 |
| <i>Cyamopsis psoralidoides</i> | | 0 | 0 | 0 | 0 | 0 |
| <i>Glycine soja</i> | | 0 | 0 | 0 | 128 | 128 |

* Low titre due to use of seeds about two years old.

Hæmagglutinins in soya bean extracts active against rabbit and rat cells, but not those of sheep and calves, have been mentioned by Liener and Pallansh.⁵ These workers noted their agglutination tests after incubation at 37° C. for 4 hours followed by storage at 4° C. for 12-18 hours. The soya bean extracts used by the present author strongly agglutinated rabbit cells at laboratory temperatures.

Seed extracts known to be inactive at laboratory temperatures might usefully be re-examined at refrigerator temperatures. This may result in the discovery of phyto-agglutinins absolutely specific for the human red cell antigen B or provide additional material for research on erythrocyte antigens.

Blood Transfusion Dept., G. W. G. BIRD.
Armed Forces Medical College,
Poona, June 13, 1953.

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FORMATION OF ISOPOLYMOLEBYDATES AND MOLYBDO-COMPLEXES

STANDARD solutions of sodium molybdate (14.68 g. of $\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ /litre) oxalic acid (19.95 g./litre), tartaric acid (36.8 g./litre) and lactic acid (exactly 1N) were prepared. A

sample of G. R. quality was used for preparing sodium molybdate solution and other solutions were standardised. In three sets of experiments, a definite volume of Na_2MoO_4 solution taken in a conical flask and diluted to the same extent (200 c.c.) was titrated conductometrically against oxalic, tartaric and lactic acids added from a micro-burette using a dip-type conductivity cell. The conductance was plotted against the volume of the titrant and breaks were obtained corresponding to the addition of about 4, 7 and 9 H ions for every $6\text{MoO}_4 = \text{ion}$ in the case of all the three acids and the curve was exactly like that reported earlier.² Glass electrode titrations were also carried out using a Marconi p_H meter. The p_H varied from 7.8 to 2.7 and the p_H values corresponding to the conductometric breaks were 6.5, 4.5 and 3.1. All these observations are in accordance with the previous work¹ on isopoly acids where either HNO_3 or HCl was used as the titrant.

Oxalic, tartaric and lactic acids, in addition to supplying the complex forming ligands (groups) supply H ions also. This decreases the p_H of the solution favouring the aggregation process. It is, therefore, necessary to investigate the complex formation under conditions not favourable for any aggregation process.

Our thanks are due to Prof. S. S. Guhasircar for his kind encouragement.

Dept. of Chemistry,
Ravenshaw College,
Cuttack, July 6, 1953.

D. V. RAMANA RAO.
S. PANI.

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SOLUBILITY PRODUCT OF BARIUM MOLYBDATE

It appears from the Landolt and Börnstein Tabellen, that the solubility product of barium molybdate has not been determined. Smith and Bradbury,¹ in 1891, concluded that 1 part of the salt is soluble in 17,200 parts of water at 23° C. The solubility product of barium molybdate is determined accurately in the present work.

Hot aqueous solutions of BaCl_2 and Na_2MoO_4 (G. R. quality), were mixed. The precipitated barium molybdate was filtered out, washed, dissolved in HCl and reprecipitated by NH_4OH . After final washing, it was thoroughly dried at 110° C. The barium and molybdenum contents were estimated gravimetrically by the sulphate and oxine methods respectively to ascertain its

purity. The experimental results in duplicate agreed well with the formula BaMoO_4 .

The solubility product was found to be 3.41×10^{-8} .

Thanks are due to Dr. S. Pani for his help in the work.

Dept. of Chemistry,
Ravenshaw College,
Cuttack, July 6, 1953.

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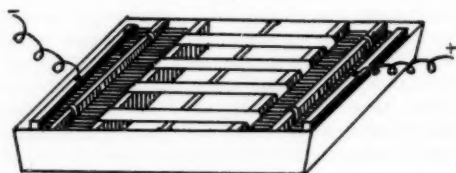
1. Smith and Bradbury, *Ber.*, 1891, p. 2930.

A SIMPLE APPARATUS FOR PAPER ELECTROPHORESIS

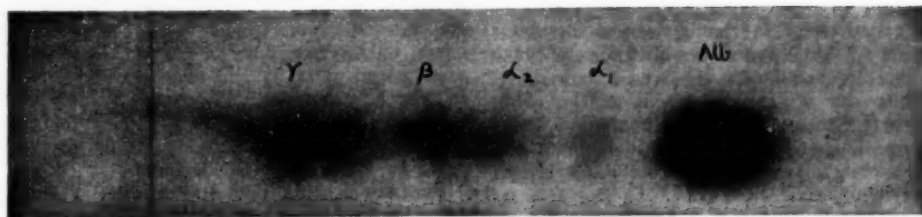
THE technique of micro-electrophoresis on filter-paper is now widely used and many different types of apparatus have been described.¹⁻⁷ A simple and inexpensive apparatus which has given us satisfactory results for nearly a year is described here.

The apparatus (Fig. 1) consists of a glass

Fig. 1



refrigerator drip tray 36 cm. \times 20 cm. \times 6 cm. divided into five compartments by four glass partition walls. The middle compartment is kept 17-18 cm. wide and the other four compartments about 4.5 cm. wide. The compartments are made water-tight by pressing in plasticine moulding compound. The height of the partition walls are kept 0.5-1 cm. less than the height of the tray. Carbon electrodes 18 cm. \times 5 cm. \times 1 cm. are placed in the two end compartments. Buffer of the required pH is then filled into all the compartments except the middle one upto a height of 0.5 cm. below the top level of the partitions. The level of buffer in all the four compartments is made the same with the help of syphons. A pair of wicks is placed over the partition walls of the electrode and adjacent compartment as recommended by Flynn and Mayo.⁵ The wicks help to keep the electrical contact between the two buffer compartments, but prevent the pH changes in the electrode compartment from affecting the adjacent compartment. A glass rod is fixed with the help of plasticine at the top edge of the



central compartment, its position depending on the direction of migration of the proteins in the particular buffer used. Four or five filter-paper strips 4 cm. wide and about 28 cm. long are taken, and on each of these a spot is marked with an ordinary lead pencil to indicate the position for applying the protein solution. The paper strips are then moistened with buffer, and excess moisture is removed by blotting. The moist papers are then placed over the central compartment so that the marked spot will rest on the glass rod and the two ends dip into the buffer compartments. A volume of serum equal to 0.005 or 0.01 ml. is put on the marked spot. The syphons are removed and the tray is covered with a glass plate. Direct current of about 0.6 mA per cm. width of paper strip at 60-120 V is passed. Electrophoresis is usually run for a period of 18-20 hours preferably overnight.

After electrophoresis, the paper strips are dried and stained for 10 minutes with 1 per cent. bromophenol blue in ethanol saturated with mercuric chloride. The excess dye is washed out with 0.5 per cent. acetic acid.⁴ For quantitative work, the dyed papers are cut into strips, the colour eluted and measured colorimetrically according to the method of Kunkel and Tiselius,³ or nitrogen is estimated directly in the cut strips by micro-Kjeldahl procedure according to the method of Levin and Oberholzer.^{5,9}

The apparatus is suitable for carrying out two-dimensional electrophoresis by using a single sheet of paper instead of strips. Paper partition chromatography can also be carried out in the second dimension, if necessary.

A thick uniform paper like Munktell 20 is particularly suited for paper electrophoresis. Whatman No. 31 is the next best. The more readily available Whatman No. 3 is suitable for blood proteins. Whatman No. 1 paper often gives rise to trailing with some proteins, though not much with blood proteins. Fig. 2 shows separation of serum proteins on Whatman No. 3 paper.

Dept. of Antitoxins and Sera,
Haffkine Institute,
Bombay-12, July 9, 1953.

S. S. RAO.

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CAFFEINE CONTENT OF COFFEE

THE estimation of caffeine is one of the important methods for deciding the purity of a sample of coffee, and it is also one of the chief methods of estimating the percentage of adulteration in cases where specific adulterants have been detected by microscopic examination. The method adopted for the caffeine estimation in this Laboratory is based on that of Fendler and Stüber.

In the course of analytical work carried out here over a period of more than two decades, the highest figure obtained for the caffeine content of genuine coffee samples varied between 1.2 and 1.7 per cent. This figure has been supported very well by the observations of Lythgoe and Leach.

Recently, however, ever since coffee became scarce and costly, interesting cases of coffee samples with abnormally high caffeine contents of 2.2 to 2.6 per cent. have been met with during the regular analysis of coffee samples in our laboratory. Such high values of caffeine are characteristic of some varieties of coffee of African origin only. The sudden increase in this important analytical figure has, therefore, to be presumed to be due to the arrival in the market of new varieties of coffee. These varieties may presumably be the African varieties cultivated in India, or cultivated varieties

obtained by crossing the Indian and African varieties.

In every case, the genuineness of the coffee was established beyond doubt by a thorough microscopic examination.

The purity of the caffeine in all the above cases was confirmed by the estimation of nitrogen on the caffeine by the Kjeldahl method. The purity was in no case less than 96 per cent. caffeine.

Public Analyst's Lab., V. VENKATACHALAM.
Ripon Buildings, S. SUNDARAM.
Madras-3, July 23, 1953.

MALFORMATIONS IN SUGARCANE

WHILE in paddy and ragi (*Eleusine coracana* Gaertn.) Anandan and Krishnaswami¹ and Diwakaran, *et al.*,² respectively by experimental work in field, and Sampath and Krishnaswami³ by cytological evidence in the case of the former, showed that the formation of a leafy shoot in place of an inflorescence was a recessive Mendelian character, Lyon⁴ who also noted a similar phenomenon in sugarcane offered no explanation. In view of the vegetative propagation in cane, it might straightaway be stated that it could not have been genetical in nature, as was the case in the two plants mentioned above.

In the course of his work on cane-breeding, the author found that of the six varieties, namely, Co 313, Co 331, Co 419, Co 508, B.O. 11⁵ and P.O.J. 2961, only Co 313 which alone flowered at Pusa developed "bunch tops" (expression used by Lyon) in 13 stalks in February 1951, 14 in March and 17 in April, thus totalling 44 out of 227 stalks observed (Fig. 1). In the case of the other five varieties 51-64



FIG. 1

stalks of each were closely watched. B.O. 11, however, was found to develop leafy shoots in three stalks towards the end of April 1951 at

Hassanpur (District Darbhanga; nearly 50 miles to the east of Pusa) where five of its stalks were in short-blade stage. Next season again, out of 288 stalks of Co 313, leafy shoot was formed in 13, 11 and 13 stalks respectively in March, April and May 1952.

On the basis of these observations the following tentative hypothesis might be put forward to explain the phenomenon.

Sugarcane being photo-periodically a short-day plant, its stalks are induced into reproductive phase in winter when the terminal growing point breaks up into so many small growth primordia to develop into rachillae of the panicle which, however, are not formed, if the fragmentation of the apical meristem takes place late in season, because with the increase in the day-length, the reproductive metabolic activities are inhibited and with the advent of still longer days, the stalk is pushed back into the realm of vegetative growth. But long-day cannot undo the modifications already effected by short-day period. As such, the daughter-primordia develop into as many leaves with the result that instead of an inflorescence, a leafy shoot is formed at the apex.

Thus the formation of a leafy shoot or of an inflorescence by the terminal growing point appears to be the end-product of a series of interactions between the environmental and physiological processes going on within a cane. The presence of a leafy shoot and an inflorescence in more or less the same plane in a very rare case (Fig. 2) appears to indicate that so far as this chain of reactions is concerned, a stalk as a whole does not behave as one entity. It seems daughter-primordia or groups of them



FIG. 2

at least are independent of each other in this respect.

Funke⁵ and Struckmeyer⁶ have experimentally effected reversion from reproductive to vegetative phase respectively in *Perilla ocymoides* and *Salvia splendens* var. *Harbinger*, while such reversion is quite a normal feature of the growth-cycle of pine-apple stem.

Grateful thanks of the author are due to Sri. K. L. Khanna, Director of this Station, for so kindly providing facilities for this work and for his keen interest in its progress.

Central Sugarcane

S. L. SHARMA.

Research Station,

Pusa, Bihar, August 30, 1952.

* B.O. is a series of sugarcane varieties bred and selected at Central Sugarcane Research Station, Pusa (Bihar).

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ARGINASE AND URIC ACID IN *ACHATINA FULICA* (FER.)

BALDWIN¹ confirmed Clementi's findings of arginase in the hepatopancreas and also found this enzyme in the nephridium of *Helix pomatia*. Recently, Lal and Saxena² reported the presence of arginase in the hepatopancreas of the common Indian apple-snail, *Pila globosa* (Swainson). The present communication deals with a study of arginase and uric acid in another form *Achatina fulica* (Fer.), introduced into India by Benson in 1847. This snail is completely terrestrial in habit and offers a good comparison with *Pila globosa* which is practically an amphibious form. The details of the experimental procedure are given below:—

For the determination of arginase the hepatopancreatic gland was dissected out of the live snail and immediately weighed. A 'brei' of the fresh tissue was prepared according to the technique of Baldwin,¹ brought to pH 9.5 and incubated with a 5 per cent. solution of L-arginine-monohydrochloride at 28° C. for 60 minutes using glycine solution as buffer. A few drops of toluene were added as an antiseptic. The urea formed was decomposed into ammonia by urease at pH 5 in the presence of acetate buffer. Ammonia was thereby estimated titrimetrically. The yield of urea-CO₂ c.cm. was duly corrected

for the tissue and solution blanks. The result is expressed here in the QH notation of Krebs and Henseleit as done by Baldwin² and is Q²⁵₁₀ 315.

For the estimation of uric acid the nephridium of the snail was weighed in tared crystal glasses, dried in hot air-oven at 110° C. for approximately two hours till its weight became constant, and the water content of the tissue was thereby calculated. The dry tissue was powdered and uric acid therein extracted repeatedly over a water-bath at 80° C. in distilled water. The extracts thus obtained were made upto the desired volume with distilled water. The uric acid in the aliquot samples of the extracts was estimated by Benedict's Colorimetric method as described by Cole³ using a Klett-Bio-Colorimeter. The yield of the uric acid was 265 mg. per gram dry weight of the tissue. Control and blank tests were performed simultaneously. All experiments were carried out at room temperature.

Lal and Saxena² did not report any appreciable quantitative difference in the occurrence of arginase in the hibernating *P. globosa* and those living in an aquarium. The accurate figures of these estimations will be published elsewhere. On the contrary no arginase was detected in those specimens of *A. fulica* which had hibernated for about six months in the laboratory.

Baldwin¹ correlated the increasing amounts of arginase found in terrestrial forms over marine and fresh-water forms to a possible uricogenesis. The yield of both arginase and uric acid is more in *A. fulica* which is a completely terrestrial form than in *P. globosa* which is an amphibious snail. This rise in the arginase content in the hepatopancreas of *A. fulica* may also be related with the elaboration of uric acid as a nitrogenous waste to some extent.

My thanks are due to Dr. M. B. Lal under whose guidance this work was completed, to Mr. B. K. Tandan for kindly obtaining the specimens of these snails for me from Madhupur, Bihar, and to Dr. S. L. Hora of the Zoological Survey of India for the identification of these snails.

Dept. of Zoology,
The University, Lucknow,
May 1, 1953.

B. B. SAXENA.

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**CHROMOSOMES OF *OPATROIDES*
VICINUS FAIRM. (COLEOPTERA:
TENEBRIONIDÆ)**

LITTLE attention seems to have been paid to the cytology of Coleoptera in this country, although quite a number of species have been studied in other countries by Stevens,¹ Nonidez,² Smith,³⁻⁵ Guenin^{6,7,8} and Yoshida.^{9,10} Our knowledge regarding the chromosomes of Indian Coleoptera is primarily due to Asana, Makino and Niiyama¹¹ and Bose.¹² The present paper reports on the chromosome number and the meiosis in a species of tenebrionid beetle, *Opatroides vicinus* Fairm., collected during the month of May 1950, at Izatnagar in the Uttar Pradesh.

Testes from adult males were dissected out in a living condition and fixed in medium flemming. Sections were cut 12 micra thick and stained in iodine crystal violet after overnight premordanting in 1 per cent. chromic acid.

The spermatogonial metaphase plate shows the chromosome number to be $2n=20$. The largest acrocentric chromosome of the complement is the X, while the smallest dot-shaped one represents the Y chromosome (Fig. 1). This

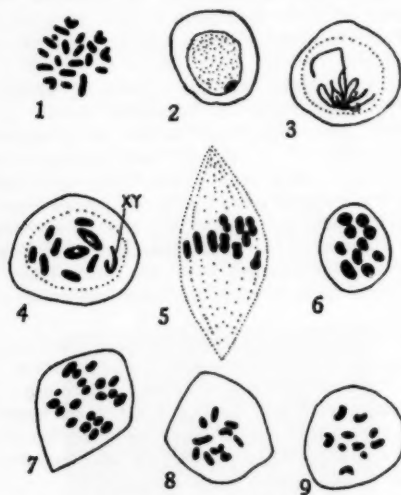


FIG. 1. Spermatogonial metaphase plate. FIG. 2. Spermatogonial resting stage. FIG. 3. Zygotene stage. FIG. 4. Diplotene stage. FIG. 5. First meiotic metaphase. FIG. 6. Metaphase I polar view. FIG. 7. Anaphase I stage. FIG. 8. Metaphase II with the X chromosome. FIG. 9. Metaphase II with the Y chromosome. Diagrams are reproduced at a magnification of 2114.

number appears to be very characteristic in three families of Coleoptera and has been recognised by Smith⁴ as the primitive cytological constitution in the order Coleoptera as a whole. A study of the chromosome complement in the present species shows fifteen acrocentric chromosomes, four metacentric ones and the Y, which is almost near the limit of visibility. The latter looks very much understained at metaphase. At spermatogonial resting stage, the X chromosome remains positively heteropycnotic and lies very close to the nuclear membrane (Fig. 2). The zygotene stage shows polarisation of all the chromosomes towards the heteropycnotic X chromosome which again is found very near the nuclear membrane (Fig. 3). At diplotene there are seven autosomal bivalents, which are rod-shaped, two ring-shaped ones and the sex bivalent (Fig. 4). The chiasmata in all the bivalents are found to be terminal at this stage. At first meiotic metaphase, the XY bivalent remains slightly understained and at first it is off the plate with the Y chromosome always oriented towards the equatorial plate (Fig. 5). Later on the sex bivalent occupies a position along with the other bivalents and, therefore, polar views of metaphase I always reveal ten elements (Fig. 6). The first division anaphase is reductional for the sex chromosome (Fig. 7) and consequently two types of second division plates are seen—one with the X chromosome and the other with the Y (Figs. 8 and 9).

The work was carried out at the Division of Animal Genetics, Indian Veterinary Research Institute, Izatnagar. The author wishes to express his indebtedness to Dr. P. Bhattacharya, for offering necessary facilities, and to Dr. A. P. Kapur, ILRI, Ranchi, for the identification of the material.

Dept. of Zoology,
University of Delhi, Delhi-8,
June 22, 1953.

M. K. DUTT.

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**OBSERVATIONS ON THE BIOLOGY OF
SCELIO HIEROGLYPHI TIMBERLAKE
(SCELIONIDAE, HYMENOPTERA)**

AYYAR¹ found *Scelio hieroglyphi* Gir. parasitising the eggs of the rice grasshopper, *Hieroglyphus banian* Fabr. at Coimbatore. Excepting this record, no observations on the incidence and biology of this important parasite appear to have been made.

Collections of egg-pods of the rice grasshopper made from the paddy fields round about Bangalore during June 1952, and incubated in moist soil in the laboratory, showed that up to 15 per cent. of the egg-pods were parasitised by the scelionid. Parasites alone (and in some cases, both parasites and hoppers) emerged from individual egg-pods. Most of the parasites emerge in the fields just after the onset of the south-west monsoon rains, i.e., June-July, when most of the hoppers from unparasitised eggs also emerge.

In the laboratory, *S. hieroglyphi* was found to attack, and successfully complete its development in the eggs of the grasshoppers, *Attractomorpha crenulata* Fabr., *Oedaleus nigrofasciatus* Sauss., *Oryza multidentata* Will., and *Phlaeoba* sp. However, *O. multidentata* was considered to be the most suitable laboratory host in view of its availability in nature, and easy rearing in the laboratory, throughout the year, and its fairly short egg-period.

Detailed observations on the oviposition-behaviour of the parasite were made by enclosing parasites along with pairs of adult grasshoppers (*O. multidentata*) in small jars in which moist soil for oviposition and grass as food of the grasshoppers were provided. One or more of the female parasites in the jar are usually attracted to the ovipositing grasshopper, and they wait for the grasshoppers to complete the act of oviposition and then immediately attack the host egg-pod, which may be laid inside the soil ($\frac{1}{2}$ " to 1" below the surface), or between clumps of grass. The ovipositor may continue to be inside the host egg-pod for over 1-1½ hours, all the time exhibiting alternate movement and apparent inactivity, after which the parasite slowly draws itself away from the host egg-pod. The parasite, though usually preferring freshly laid eggs, has been sometimes seen to attack one or even two-days-old eggs, when enclosed along with them, and to successfully complete its development.

All the early stages (egg, larva and pupa) of the parasite are passed within the host-egg, only one parasite completing its development in each

egg. Almost the entire contents of the parasitised egg may be consumed by the time the parasite pupates within the host-egg. The time required for one generation, from egg-laying to emergence of the adult, ranges from 29 to 35 days, which compares well with the incubation period of the grasshopper. The duration of the emergence of the parasites from a parasitised egg-pod may extend up to a week. Both male and female parasites and hoppers from unparasitised host-eggs emerge almost at the same time from individual egg-pods.

The adults are active immediately after emergence and move about briskly on the sides of the breeding jar, on the soil at the bottom and even actively get into cracks and crevices in the soil. When disturbed, they drop down exhibiting the death-feigning habit for one or two seconds, and then resume their activity. The adults live for a period of 8-12 days without apparently taking any food except water, that may settle on the glass jar. The size of the adult varies directly with the size of the host-egg, the one reared from the eggs of *Oryza* being the smallest and that from the rice grasshopper the largest and the rest intermediate in size.

Further detailed observations are in progress and the results will be published in due course.

The author is indebted to Sri B. Krishnamurti for encouragement. He is also thankful to Dr. C. F. W. Muesebeck, U.S.D.A., for the identification of the parasite; and to the Director, Commonwealth Institute of Entomology, London, for the determination of the grasshoppers mentioned in the note.

Div. of Entomology, G. P. CHANNA BASAVANNA.
Dept. of Agriculture,
Bangalore, June 3, 1953.

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**VERNALISATION RESPONSE IN *LENS
ESCULENTA* MOENCH**

With a view to find out whether *Lens esculenta* responds to low temperature treatment and to determine the optimum time of chilling to produce maximum earliness, work was undertaken by the author in 1948. The results are presented in this paper.

Vernalisation response was studied by soaking the seeds of variety 4315-1 for 24 hours in water and then chilling them at 6-9° C. for 8, 16, 24 and 32 days in a refrigerator. Proper care was taken to see that germination of seeds

did not stop due to lack of moisture. The sprouted seeds were sown along with a control in replicated progeny rows. There were 5 plants in each row and 4 replications. Data regarding the duration of vegetative phase for different treatments is given in Table I and Table II gives the analysis of variance.

TABLE I
Duration of the vegetative phase

| Period of chilling | Duration of vegetative phase Replications | | | | Mean |
|--------------------|---|------|------|------|-------|
| | 1 | 2 | 3 | 4 | |
| Days | Days | Days | Days | Days | Days |
| 32 | 42.6 | 42.2 | 42.4 | 42.6 | 42.45 |
| 24 | 51.0 | 50.8 | 52.0 | 51.0 | 51.20 |
| 16 | 53.8 | 54.4 | 53.4 | 54.2 | 53.95 |
| 8 | 56.6 | 56.4 | 57.0 | 57.4 | 56.85 |
| Control | 62.4 | 62.0 | 64.4 | 63.4 | 63.05 |

TABLE II
Analysis of variance

| Variance due to | Degrees of freedom | Sum of squares | Mean sum of squares | F. value | |
|-----------------|--------------------|----------------|---------------------|------------|-------|
| | | | | Experiment | Table |
| Blocks | 3 | 1.64 | .546 | .02 | .. |
| Treatments | 4 | 702.58 | 175.645 | 9.5 | 3.11 |
| Error | 12 | 221.5 | 18.458 | .. | .. |
| Total | 19 | 925.72 | | | |

It is seen from the value of critical difference which is 6.60237 at 5 per cent. level of significance that there is no significant difference between 8, 16 and 24 days' treatments but 32 days' treatment shortens the vegetative cycle significantly both over control and rest of the treatments. This shortening of the vegetative cycle in 32 days' treatment was by nearly 21 days. Pal and Murty¹ produced earliness in different varieties of gram, namely, IP₁₇, IP₇₀, IP₄₈ and IP₉ of 10.22, 12.05, 12.5 and 13.22 days respectively. They also produced an earliness of 1.17 days in soyabean.

Thus the optimum time of chilling for *Lens esculenta* seeds is 32 days at 6-9°C. to produce an earliness of about three weeks.

My thanks are due to Dr. Bahadur Singh, Dr. N. K. Anantrao and Dr. S. C. Chakravarti for valuable guidance.

Dept. of Biology,
A. S. Jat College, Lakhaoti,
Bulandshahr, April 1953.

T. C. SHUKLA.

¹ Pal, B. P. and Murty, G. S., *Pl. Breed.*, 1941, 1, 61-86.

SOME NEW HOSTS OF CEPHALEUROS FROM BIHAR

In this paper, an attempt has been made to record a number of hosts of the alga, *Cephaleuros*, collected from different parts of Bihar.

In order to know the epiphytic or parasitic nature of the alga, hand sections were cut, stained and studied. In *Mimusops hexandra* Roxb. collected from Patna, it was found that the alga is parasitic, as a major portion of it is intramatrical. In the case of *Psidium guava* L. collected from Patna, the alga is parasitic as reported.¹

But in the case of the hosts mentioned below, the alga is epiphytic.

PATNA.—*Dalbergia sissoo* Roxb., *Alstonia scholaris* Brown., *Mangifera indica* L., *Albizia lebbek* Benth., *Barringtonia acutangula*, Gaertn., *Achras sapota* L., *Eugenia jamboliana* Lamk., *Magnolia glauca* L., *Cordia myxa* L., *Putranjiva roxburghii* Wall., *Nephelium litchi* Camb., *Butea frondosa* Roxb., *Magnolia grandiflora* L., *Citrus medica* L. RAJGIR.—*Carissa carandus* L. RANCHI.—*Murraya exotica* L., *Thea sinensis*. PARASNATH HILLS.—*Loranthus longiflorus* Desr., *Cleodendron infortunatum* Gaertn.

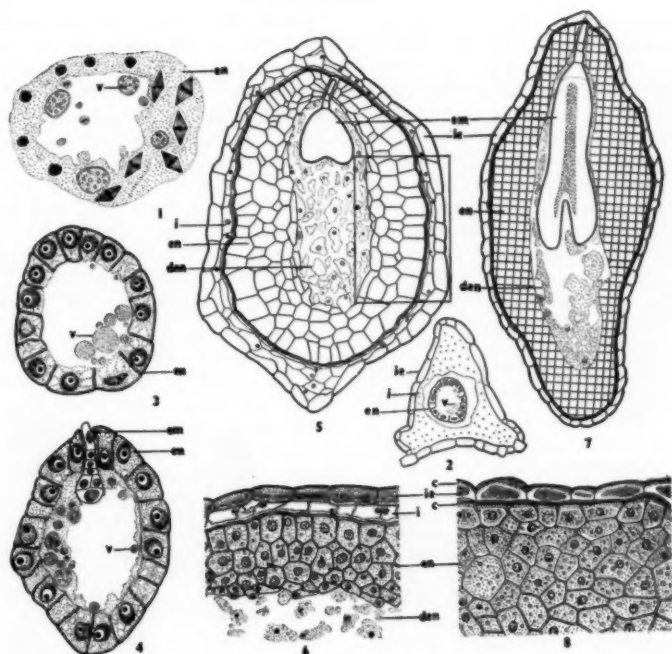
Dept. of Botany, Science College, A. S. YADAV.
Patna, May 6, 1953.

¹ Safeeulla, K. M. and Govindu, H. C., *Jour. Mys. Uni.*, 1948, 7, 47

THE ENDOSPERM AND SEED STRUCTURE OF OLDENLANDIA CORYMBOSA LINN.

RAGHAVAN AND RANGASWAMY¹ noted that in *Oldenlandia alata* the endosperm is nuclear and wall-formation takes place when the proembryo has reached the quadrant stage. The developing endosperm encroaches upon the integumentary cells and only a thin layer of the latter persists in the mature seed. Since the endosperm of *O. corymbosa* shows some interesting features which have not been reported earlier in the family Rubiaceae, a brief account is given here.

The primary endosperm nucleus undergoes several synchronous free nuclear divisions and the daughter nuclei take up a peripheral position delimiting a large central vacuole (Fig 1). During these changes the zygote remains inactive. It divides after about 32 endosperm nuclei have been formed. Wall-formation is initiated when the proembryo has reached the four-celled stage.



FIGS. 1-8. *Oldenlandia corymbosa* Linn. (c, cellulose thickening; den, degenerating endosperm; em, embryo; en, endosperm; i, integument; ie, integumental epidermis; v, cytoplasmic vesicle). Fig. 1. T.S. of embryo sac showing endosperm and, cytoplasmic vesicles (before wall-formation), $\times 62$. Fig. 2. T.S. of young seed $\times 17$. Fig. 3. Detailed structure of endosperm and cytoplasmic vesicles shown in Fig. 2, $\times 62$. Fig. 4. L.S. of endosperm and embryo, $\times 62$. Fig. 5. L.S. of young seed showing central degenerating endosperm different from the peripheral endosperm, $\times 28$. Fig. 6. Detailed structure of a portion of endosperm and integument shown in Fig. 5, $\times 37$. Fig. 7. L.S. of almost mature seed, $\times 28$. Fig. 8. Detailed structure of testa and endosperm of a mature seed $\times 37$.

Prior to wall-formation certain cytoplasmic vesicles begin to protrude into the central vacuole. Gradually they become rounded and are finally cut off from the general cytoplasm containing the endosperm nuclei. The vesicles do not possess any nuclei but vary in size and are irregularly distributed (Figs. 1-4). With the centripetal extension of the endosperm cells the vesicles diminish in size and number and finally disappear. Such cytoplasmic vesicles in the endosperm have not been reported previously in any plant of the Rubiaceae.

Recently the presence of non-nucleated cytoplasmic vesicles has been reported in *Pennisetum typhoides* Rich. (Narayanawami²). Endosperm vesicles have also been reported in *Musa*,³ *Musa errans*⁴ and *Isomeris arborea*⁵ but in these cases the vesicles are nucleated. In *Isomeris* the vesicles are said to give rise to embryos. No such case has, however, been noted in *Oldenlandia corymbosa*.

Periclinal divisions take place in the outer layers of the endosperm which now fills the embryo-sac and at the same time encroaches upon the adjacent integumentary cells which are gradually consumed until only the epidermis is left. The cells of the latter contain tannin and at maturity the outer tangential walls become thickened due to the deposition of hemi-cellulose (Figs. 6, 8).

The endosperm cells contain large starch grains and some crystalline material which stains black with iron-haematoxylin (Figs 6, 8). These cells, which are adjacent to the heart-shaped proembryo, appear famished and lie in a loose mass (Figs. 5, 6 and 7). As the embryo grows, they are gradually consumed until only 3-5 layers of the endosperm cells are left (Fig. 6). In *Phyllis*⁶ also, another member of the Rubiaceae, the endosperm cells lying in close proximity of the proembryo degenerate and lose their contents but the "latticework" of

their walls remains intact. The cells of the peripheral endosperm layer become highly thick-walled due to the deposition of hemi-cellulose which gradually extends to the inner cells (Fig. 8).

The mature seed of *Oldenlandia corymbosa* consists of a typical dicotyledonous embryo and 3-5 layers of endosperm cells, enclosed in a single-layered testa (Fig. 7). A one-layered testa has also been reported in other members of the family Rubiaceae, viz., *Callipeltis cucularia* and *Sherardia arvensis*⁷ and *Borreria hispida*.⁸ On the other hand, in *Oldenlandia alata*, *Dentella repens*¹ and *Vaillantia hispida*⁷ the testa is two-layered.

I am grateful to Prof. P. Maheshwari and Dr. B. M. Johri for suggesting this problem and for their helpful guidance.

Dept. of Botany,
Aligarh Muslim University,
Aligarh, July 1, 1953.

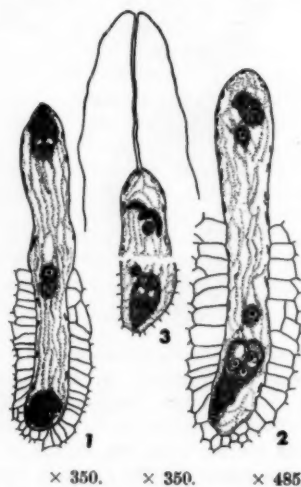
M. FAROOQ.

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INVERTED POLARITY IN THE EMBRYO-SAC OF SAURAUJA NAPAULENSIS DC.

In the development of the Polygonum type of embryo-sac, the division of the primary micropylar and antipodal nuclei is a well studied phenomenon. The micropylar quadret, in the mature embryo-sac exhibits more or less a specific pattern, whereas the chalazal quadret is subject to many kinds of variations. Sometimes the primary chalazal nucleus may divide a number of times or there may be reductions in the usual number of divisions (Maheshwari, 1948). The antipodals may divide or persist, either before, or after, or till, the stage of fertilisation. Cases are also known where there is a marked similarity between the micropylar and chalazal quadrets. Some extreme cases are also on record (Swamy, 1946), where the antipodals which appear like the normal egg apparatus persist until the time of fertilisation, and the micropylar unit shows similarity to normal antipodals. Such cases of inverted polarity have been observed in several families of angiosperms though they are not of frequent occurrence.

During the course of an embryological investigation in Ternstroemiaceae, the writer has observed a case of inverted polarity in *Saurauja napaulensis*. In this form, the development of the embryo-sac is according to the polygonum type. The normal embryo-sac is long with an egg apparatus that includes the two-hooked synergids and an egg; the two polars that usually meet in the centre, and lastly the three antipodal cells which are situated in the chalazal end (Fig. 1). In a few cases, however, the phenomenon of "inverted polarity" has been observed. In the micropylar region, there are



three antipodal cells, and the micropylar polar is about to migrate. The three nuclei of the antipodal pole, on the contrary, are organised into typical cells and show a remarkable similarity to the normal egg apparatus. The synergids show the basally situated vacuoles and their hooks are just developing (Fig. 2). In still another case, the nuclei at the micropylar end show signs of degeneration, whereas the chalazal quadret appears like a normal egg apparatus (Fig. 3).

My sincere thanks are due to Prof. L. N. Rao and Dr. S. B. Kausik for suggestions; and the University of Mysore for the award of a Research Fellowship.

Dept. of Botany,
Central College,
Bangalore, July 29, 1953.

A. NAGARAJA RAO.

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REVIEWS

The Stability of Rotating Liquid Masses. By R. A. Lyttleton. (Cambridge University Press), 1953. Pp. 147. Price 35 sh. net.

The aim of the book is to give in clear and concise manner the chief contributions to the classical problem of mathematical astronomy, viz., the stability and evolution of rotating gravitating liquids. Chapter I gives a historical development of the subject, and discusses the contributions of the greatest mathematicians like Newton, Clairaut, Maclaurin, Jacobi, Poincaré, Tchebycheff, Liapounoff and Jeans to this problem. Chapter II is devoted to the study of the stability of statical and dynamical systems. Criteria are developed for systems rotating with constant angular velocity. Ordinary and secular stabilities are described in some detail and the conclusion is reached that in some problems of cosmogony ordinary stability may be equally or perhaps more important than secular stability.

Chapter III deals with the stability of a spherical form, which evidently corresponds to the case of uniform density and no angular momentum. In Chapter IV, spheroidal and ellipsoidal forms are found as possible forms of equilibrium, when the density is uniform. The stability of Maclaurin spheroids and Jacobi ellipsoids is also discussed for certain ellipsoidal deformations. Chapters V and VI are concerned with finding solutions of Laplace's equation in terms of ellipsoidal harmonics. Lamé's functions are introduced and some properties of these functions are developed with special reference to gravitation. In Chapters VII and VIII, the secular stability of the Maclaurin spheroids and Jacobi ellipsoids is discussed. When certain restricted second order displacements are only allowed the Maclaurin series gives rise to the Jacobi series. There exists another point of bifurcation on the ellipsoidal series which gives rise to pear-shaped figures. This series is secularly unstable initially. If entirely undisturbed, it would continue in rigid-body rotation. Even for a slight disturbance the system would gradually depart from the pear-shaped form and settle down to the Jacobi form possessing the same angular momentum. This, however, being unstable the further evolution of the system will depend on its ordinary stability. In Chapter IX general equations of small motion of a rotating non-

viscous liquid are set up. Neglecting the quadratic terms of inertia in the equations of motion it is shown that ordinary stability ceases with secular stability, with the result that the series becomes unstable after the bifurcation of pear-shaped forms. In the concluding chapter the cosmological implications of the conclusion reached in earlier chapter are discussed, and it is shown that dynamical evidence is wholly against the fission hypothesis of Jeans.

This book should prove of great interest to astrophysicists, astronomers and mathematicians.

B. R. SETH.

Data for X-Ray Analysis, Vol. I. Charts for Solution of Bragg's Equation. By W. Parrish and B. W. Irwin. Pp. 81. Vol. II. **Tables for Computing the Lattice Constant of Cubic Crystals.** By W. Parrish, M. G. Ekstein and B. W. Irwin. (Philips Technical Library), 1953. Distributors: Philips Electrical Co. (India), Ltd., Calcutta 20. Pp. 99. Price Rs. 10 each.

The volumes under review are the first two of a series of publications proposed to be brought out by the Philips Technical Library, with the idea of supplementing the tables available in the International Tables for X-ray crystallography. The first volume contains a set of 85 charts for rapidly obtaining the lattice spacing d from the Bragg angle θ for various radiations (the K lines of Mo, Cu, Co, Fe and Cr). Each chart covers a range of 2.5° for θ , and the charts give the d -spacing correct to 0.01 \AA in the range 3° to 18° and to 0.001 \AA at higher angles. The charts are easy to read and are found to be very convenient to use. They are particularly useful in interpreting powder diffraction lines.

The second volume contains tables which enable one to calculate the lattice constant a of a cubic crystal from the measured glancing angle θ . In the well-known relation between the two, viz., $a = \sqrt{N}(\lambda/2)/\sin\theta$, ($N = h^2 + k^2 + l^2$), the quantity $\sqrt{N}\lambda/2$ is tabulated for several wavelengths for the various reflections hkl upto $N = 378$ for Cu and similarly for the other wavelengths. In order to extrapolate the values obtained from these to $\theta = 90^\circ$, tables of $\sin^2\theta$ and of $\frac{1}{2}\left(\frac{\cos^2\theta}{\sin^2\theta} + \frac{\cos^2\theta}{\theta}\right)$, the two commonly used functions, are tabulated. The volume also

contains a table of lattice constants of cubic substances and schematic diagrams showing the diffraction patterns of representative cubic substances.

It was a happy idea of the Philips Laboratories to have brought out these tables in such a handy form. The graphs and tables are printed neatly with easy-to-read large types and the reviewer feels that they will be widely appreciated by all X-ray workers. The appearance of further volumes in the series will be eagerly awaited.

G. N. RAMACHANDRAN.

Die Gas Turbine. By J. Kruschik. (Wien-Springer), 1952. Pp. xi + 469. Price \$ 15.00.

The book can be regarded as a well arranged compilation of the general knowledge and published data in the field of Gas Turbine Technology. A number of cycles are considered in their thermodynamic aspects, and the data for their theoretical treatment are given. A large proportion of the book is directed to the design of compressor, turbine, heat exchanger and combustion systems, and in this respect, the book gives an excellent account of current practice, especially if the chapter on materials, added later in the volume, is considered along with the design problems. A number of tables and other information will prove helpful to the designer. The behaviour under varying conditions of work of different arrangements of the main components is considered in detail and the influences of regeneration of heat, inter-cooling and reheat are established along with part load characteristics of different cycles. The advantages of closed cycle which render it essential if the utilization of lower grade fuels is intended, are well presented, and a short account is given also of the rather complicated so-called semi-closed cycle. The book ends with a large chapter on the fields of applications of gas turbines for stationary purposes, for road and rail transport, for ships, and lastly for aviation, in its two forms of the pure jet and the prop jet.

It may be said that the book would have been even more useful if its scope had been restricted somewhat. The account on heat exchangers, for example, could have been more thorough, and similar matter should be extended perhaps at the expense of the descriptive parts. Thereby the danger would also be avoided that the book becomes obsolete too quickly due to the fast developments in the field. For later editions it may be advisable to subdivide the book into two volumes which would allow adequate coverage of the subject.

In spite of these remarks the book is very valuable for the advanced scholar and the practical engineer, and it is recommended wholeheartedly.

H. A. HAVEMANN.

Reactivity of Free Radicals. (*Discussions of the Faraday Society*, No. 14). (The Aberdeen University Press Ltd.), 1953. Pp. 256. Price 35 sh.

The volume under review contains a report of the general discussion on the reactivity of free radicals held in Toronto under the auspices of the Faraday Society during 1952.

Since the previous discussions of the Society on 'free radicals' in 1934 and 'the labile molecule' in 1947, the need has been felt for quantitative data on reaction rates, activation energies, bond-dissociation energies, etc., as applied to radicals. The present discussion may be said to have made substantial contribution in that direction.

The absorption spectra of amide radicals in explosions and photochemical reactions between chlorine and oxygen, have been studied by flash photolysis in the gas phase. The technique of mass spectrometry has been employed for the determination of the concentrations of free radicals produced by the thermal decomposition of ethylene oxide, propylene oxide, etc. The reaction of methyl radicals with hydrogen isotopes, of atomic hydrogen and active nitrogen with ethane and other hydrocarbons, and photochemical radical reactions involving diethyl ketone, nitric oxide, etc., are some of the other reactions also discussed.

Referring to the liquid phase, the following have received exhaustive treatment—kinetics of photo-oxidation of various substituted anthracenes in hydrocarbon solvents, addition of bromotrichloromethane to cyclohexene and amyl acetate, oxidation of benzene by ferrous-hydrogen peroxide system, reactions between cumene hydroperoxide and polyethylene polyamines, mechanism of catalytic action of trace metals in auto-oxidation reactions, liquid phase olefinic oxidations by hydroperoxide catalysis, etc.

The discussion has provided enough material to put the chemistry of radicals on a sound quantitative footing and will prove a valuable guide and reference work for those who are engaged on research in olefin oxidation, polymerization, photo-chemistry and allied subjects.

M. SANTHAPPA.

The Chemistry and Physiology of the Nucleus. (Experimental Cell Research Supplement 2), 1952. (Academic Press Inc., New York), 1952. Pp. ix + 402. Price \$7.00.

During the past decade increasing attention has been focussed on the chemistry and physiology of the nucleus. Genes are accepted today as chemical entities belonging to the class of nucleoproteins. The chemical and physical structure of nucleoproteins have thus become of absorbing interest in attempts to evaluate the biological individuality of the genes (Stern, K. G., "Problems in Nuclear Chemistry and Biology"). The suspicion that evolutionary advances may be accompanied by increase in the complexity of the DNA seems to have been confirmed by the analytical results on a variety of organisms. The DNA's of some bacterial viruses are composed of "only three kinds of nucleotide, while other viruses and bacteria contain four, and those of some higher animals and plants have five" (p. 213, Wyatt, C. R., "Specificity in the Composition of Nucleic Acids"). It is now considered possible that there may be as many "DNA's as there are genes in the cell" (p. 195, Bendich, A., "Studies on the Metabolism of Nucleic Acids"). The curious fact remains that recent advances have tended to confuse rather than clarify the vital problem of the biological function of nucleic acids.

Contributions to the symposium include: "Nucleoproteins of the Nucleus" (Pollister, A. W.), "Role of Nucleus in Protein Synthesis" (Haurowitz, F. and Crampton, C. F.), "Chemical Action of X-Rays on Nucleic Acids and Related Substances in Aqueous Systems" (Scholes, G. and Weiss, J.), "Enzymes of Isolated Nuclei" (Dounce, A. L.), "Histochemical Demonstration of Nuclear Enzymes" (Novikoff, A. B.), "Evidence for the Polynucleotide Nature of Cysteinylglycinase" (Binkley, F.), "Organization and Function of Inorganic Constituents of Nuclei" (Poulson, D. F. and Bowen, V. T.), "Effect of Purines and Other Chemotherapeutic Agents on Nuclear Structure and Function" (Bieseke, J. J., Berger, R. E., Clark, M. and Weiss, L.), "Chromosome Metabolism as Shown by Autoradiographs" (Pelc, S. R. and Howard, A.), "Origin of Bacteriophage Nitrogen, Carbon and Phosphorus" (Putnam, F. W.), "Fate of the Infecting Virus Particle" (Kozloff, L. M.), "Biological Nature of Bacterial Transforming Factors" (Hotchkiss, R. D.), "Lampbrush Chromosomes" (Gall, J. G.), and "Relationships between Ionizing Radiation, Chromosome Breakage and Certain Other Nuclear Disturb-

ances" (Sparrow, A. H., Moses, M. J. and Dubow, R. J.).

As in any rapidly advancing field, there is a large amount of speculation. Discussions of the papers are stimulating.

There is considerable divergence of opinion as to the structure and behaviour of the bacterial nucleus. The views of the American workers find emphasis in the paper, "Current Status of the Bacterial Nucleus" (Delamater, E. D., Hunter, M. E. and Mudd, S.). Bacterial cytology will remain a controversial field so long as no attempt is made to correlate results obtained on the same organism under a variety of cultural conditions. Inoué's studies ("The Effect of Colchicine on the Microscopic and Submicroscopic Structure of the Mitotic Spindle") with a polarization microscope indicate that spindle fibres seen in cytological preparations may not after all be artifacts.

The increased interest in the chemistry and physiology of the gene should not lead one to conclude that further advances in cytology and genetics along the classical lines have come to a stop. In a very thought-provoking article ("Interrelations between the Nucleus and Cytoplasm: Problems at the Biological Level") Schultz analyses some of the basic problems. Proof for the linear order of genes is afforded by the test of crossing over and as such it was assumed that crossing over takes place only between genes. Loci formerly thought to be single have turned out to be quadruple. Subgenes are visualized. The behaviour of the nucleus during tissue differentiation continues to remain intriguing. There is differential multiplication of chromosomes when cells become endopolyploid. It is possible that different rates of reproduction of heterochromatic and euchromatic regions of chromosomes may be responsible for the activation of specific genes during tissue differentiation.

The volume has justified the hope of the organisers. It affords a picture of the present position in the several divergent fields and offers indications for future lines of research. It would be a valuable addition to any library.

M. K. SUBRAMANIAM.

Blood Cells and Plasma Proteins. Edited by James L. Tullis. (Academic Press Inc., New York), 1953. Pp. xxii + 436. Price \$8.50.

This volume is the second in the series of memoirs of the University laboratory of physical chemistry related to medicine and public health of Harvard University, and has resulted from the deliberations in seminars dealing with

the intricate problems of blood cells and plasma proteins and their state in nature. Many brilliant investigators in this field have presented their findings and, to Dr. James L. Tullis must go the full credit for arranging the material available in such an excellent manner. The different contributions in the book have been divided into seven general categories. In the first section, comprising four chapters, Dr. E. J. Cohn, the doyen of investigators in this particular field, has dealt most appropriately with the discovery, characterization and separation by virtue of their physical properties and chemical interaction, of the various formed and fluid constituents of human blood. In the next section, the complex factors concerned with blood coagulation are discussed in five chapters by several authors, while the components of human blood concerned with immunity are dealt with in the third section by Dr. Janeway and others. Two further sections deal with erythrocytes and leucocytes, and particular mention may be made here of Dr. Denstedt's article for the remarkable presentation of new and thought-provoking data on the enzymology of the erythrocyte. The sixth section on plasma enzymes has been adequately covered by Dr. Surgenor and his colleagues, while in the final section on lipoproteins of blood and other tissues, there are a number of interesting articles such as lipoproteins of human plasma and linkages between proteins and lipids. It is gratifying to note that, in this volume, the vast amount of literature on blood cells and plasma proteins which has hitherto remained scattered in a number of publications has been assembled for the first time in such a manner as to give a co-ordinated and clear picture of the present status of the subject. It should, therefore, appeal to every one who is interested in either the components of blood cells or the characteristic behaviour of the plasma proteins.

P. S. SARMA.

Text-Book of Physics for the B.Sc. Students, Part I. (*Mechanics, Properties of Matter, Wave Motion, Sound and Light*). Pp. xiii + 451. Part II. (*Heat, Electricity and Magnetism*). Pp. xii + 509. By Snehahamay Datta (A. Mukherjee & Co., Calcutta), 1952. Price Rs. 7-8-0.

As a text-book meant for the use of the students of the Pass Course in B.Sc. of our Universities, the appearance of these volumes will be welcomed. They cover the syllabus completely and are very well produced. Besides the usual questions and problems on the text, there is also a summary at the end of each

chapter, which is bound to be very useful to the student. The volumes are well illustrated and adequately indexed.

Challenge of the Unknown. By Louis K. Anspacher. (George Allen & Unwin, Ltd., London), 1952. Pp. 324. Price 16 sh.

Dr. Anspacher was associated with Professor Hyslop for many years in the early stages of the American Society for Physical Research, and his book may well serve to introduce readers to the growing mass of information on occult phenomena. The case for psychics is here presented with many examples of telepathy and clairvoyance, which were compiled after years of investigation. The fascinating story of the Elberfeld horses, which are said to have solved mathematical problems that baffled many experts, is also presented here in popular form. The book will be read with profit by all those interested in the study of the paranormal and the extra-sensory perceptions which perhaps define the boundary between the known and the unknown.

Books Received

The Chemistry of Heterocyclic Compounds; Condensed Pyridazine and Pyrazine Rings. By J. C. Simpson. (Interscience Publishers, Inc.), 1953. Pp. xvi + 394. Price \$12.50.

Crystal Structures. By Ralph W. G. Wyckoff. (Interscience Publishers, Inc.), 1953. Section III, Price \$14.50. Supplement II, Price \$4.00.

Principles of Electronics. By H. Buckingham and E. M. Price. (Cleaver-Hume Press), 1953. Pp. 335. Price 15 sh.

Small Transformers and Inductors. By K. A. Macfadyen. (Chapman & Hall), 1953. Pp. xii + 237. Price 37 sh. 6d.

The Atomisation of Liquid Fuels. By E. Giffen and A. Muraszew. (Chapman & Hall), 1953. Pp. ix + 246. Price 36 sh. net.

An Introduction to Qualitative Chemical Analysis. By A. V. Katti. 1953. Pp. ix + 89. Price Rs. 2.

Advances in Veterinary Science, Vol. I. Edited by C. A. Brandly and E. J. Jungherr. (Academic Press), 1953. Pp. xi + 317. Price 37 sh. 6d. net.

Nutrition in India. By V. N. Patwardhan. ("The Indian Journal of Medical Sciences", Bombay 4), 1952. Pp. viii + 345. Price Rs. 10.

Technique of Organic Chemistry, Vol. VIII. (Investigation of Rates and Mechanisms of Reactions). Edited by S. L. Friess and A. Weissberger, 1953. Pp. xxiii + 760. Price \$12.50.

SCIENCE NOTES AND NEWS

Chemical Control of Nut Grass *Cyperus rotundus* L.

Messrs. C. Thakur and H. N. Singh, Central Sugarcane Research Station, Bihar, report that chemical control of nut grass, a pernicious perennial weed, can be obtained by means of the commercial weedicides—fernoxone (containing 80 per cent. sodium salt of 2, 4-D: 0.125 per cent. and 0.25 per cent. concentration), phenoxy-lylene 30 (Pest Control Ltd., Cambridge: 0.33 per cent. and 0.66 per cent. concentration), and 2, 4-D (2, 4-Di-chlorophenoxyacetic acid: 0.5 per cent. and 1.0 per cent. concentration—at the rate of 100 gallons per acre. Of these, the former two were found to be more effective than 2, 4-D. Plants in blossoms resisted the effect of chemicals in all cases to a greater extent than non-flowering plants. In the lower dosage slight yellowing was noticed in some plants and they recovered very soon to the normal condition. The after-effects of these chemicals will be reported in detail later. Grateful acknowledgement is made to Sri. K. L. Khanna for providing necessary facilities for work.

Equipment for Raman Spectroscopy

Messrs. Hilger & Watts Ltd., London, have designed a spectrograph which facilitates the employment of Raman effect in industry and in research. The equipment consists of: (1) source unit, (2) large aperture, two-prism spectrograph with alternative cameras, (3) direct recording equipment, (4) scanning attachments, (5) vibrator, photomultiplier, amplifier, oscillator and supply unit. The equipment is sensibly linear over the whole of the operating range.

New Derivatives of Cortisone

Both cortisone and hydrocortisone occur naturally in the vertebrate adrenal cortex, and, as is well-known, are being used in treating rheumatoid arthritis, rheumatic fever and many other diseases. By means of the rat liver glycogen test, an assay used in evaluating compounds for cortisone-like activity, Drs. A. Borman and P. M. Singer of the Squibb Laboratories, U.S.A., established that three of the new halo-derivatives prepared by them approach cortisone in activity, while two exceed it.

One of the compounds, 9- α -chloro-17- α -hydroxycorticosterone, was shown to be found

four times as active as cortisone. This is significant since in the past authorities in the field have held it unlikely that substances more active than cortisone could be synthesized in the laboratory. Meanwhile the new compounds are being tested with laboratory animals and full evaluation must await clinical trials.

Synthesis of Hydrazine by New Method

Hydrazine—the basis of rocket fuels and the new anti-T.B. drug Isoniazid—has been synthesized by a new process developed in the U.S.A. The starting material is ammonia or urea. Using a high frequency discharge to keep heating effects to a minimum, the method yields 4.6 g. of hydrazine per kWh. of energy dissipated in the discharge tube. High flow rates through the discharge tube, small discharge currents, low pressures and small electrode gap distances favour yields.

Weather in the Upper Atmosphere

A new meteorological station has been established near Crawley, in Sussex, with automatic radar-sonde equipment for observing accurately the weather in the upper atmosphere. The equipment used was evolved directly from the existing radio-sonde system and is designed to meet the greater accuracy demanded of meteorological forecasting.

A radar transmitter-receiver, or transponder, is carried aloft by a free balloon and is interrogated automatically by radar pulses from the ground station. The height at which soundings can be made is limited largely by the bursting point of the balloon. The radar-sonde equipment is capable of operating at a ceiling height of at least 100,000' and wind speed and direction, temperature, pressure and humidity can be measured at ranges of up to 100 nautical miles. The balloons are released from the ground station at certain internationally agreed times and signals are received from the transponders by an automatic following aerial at the ground station. The whole process of recording, computing and telemetering is automatic.

New Monochromator

A new monochromator, developed by Fischer Scientific Co., U.S.A., gives high intensity monochromatic light of any desired frequency. The heart of the monochromator is its certified-

precision plane diffraction grating, ruled 600 grooves per mm. The monochromator has an efficiency of 65 per cent. at a wavelength of 265 m/μ in the first order. The grating is mounted so that its full first-order spectrum is swept across the exit slit by a screw drive, which is turned by a drum graduated directly in mμ.

Streptohydrazid for T. B.

The Tuberculosis Chemotherapy Trials Committee of the British Medical Research Council announced recently that the best treatment now available against T.B. is a combination of the isoniazid (INH), with streptomycin. The dosage is 1 g. of streptomycin and 200 mg. of isoniazid daily.

It is now possible to give both these drugs—in almost exactly these proportions—in a single injection, for they have been chemically combined into one substance. This combination, called streptohydrazid, also helps to avoid the unpleasant stomach upsets and other side-effects which sometimes occur when isoniazid is given by mouth.

Symposium on Milk and Milk Products

It is proposed to hold a symposium on recent progress in biochemical research on milk and milk products, under the joint auspices of the Society of Biological Chemists, India, and the Indian Dairy Science Association, during the Easter recess of 1954. Those intending to take part in the symposium may please contact the Hon. Secretary, Society of Biological Chemists, India, Indian Institute of Science, Bangalore 3, or the Joint Secretary, Indian Dairy Science Association, Indian Dairy Research Institute, Bangalore.

Ophthalmology Institute

The Government of India have sanctioned Rs. 1,30,000 for construction of an Institute of Ophthalmology for post-graduate studies and a recurring grant of Rs. 20,000 for its maintenance in Aligarh. The Institute will be attached to the Gandhi Eye Hospital and will operate in collaboration with the Aligarh University.

Pharmaceutical Committee

A Committee has been appointed by the Government of India to undertake a comprehensive enquiry into the pharmaceutical industry. Among other things, the Committee is to study the operations of foreign concerns and Indian concerns with foreign associations. A questionnaire has been circulated to the industry calling for details about price structure and imports of raw and semi-processed materials.

Research Degree Awards

The Andhra University has awarded the Degree of Doctor of Science in Biochemistry (Medical), to Mr. B. Naganna for his thesis entitled "Pyro-Phosphates".

The University of Madras has awarded the Ph.D. Degree in Physics to Mr. Gopinath Kartha for his thesis entitled 'Studies on X-Ray Crystal Structure Analysis'.

Rajasthan Academy of Sciences, Pilani

Office-bearers for 1953-54: *President*: Dr. P. Nilakantan, *Vice-Presidents*: Dr. K. M. Gupta, Dr. A. K. Chatterji, Prof. M. L. Schroff, Dr. M. L. Roonwal, Dr. G. S. Mahajani; *Secretary*: Prof. K. Ramamurti; *Treasurer*: Prof. Roshan Singh.

Standards of Isotopes

For some time past, the need has been felt for absolute standards for radioactive isotopes. As the National Physical Laboratory, England, has at present the main responsibility for standards of certain radioactive isotopes in Great Britain, it is proposing to issue standards of these isotopes at regular intervals to meet the needs of those whose use of such materials justifies absolute standards and to supplement the normal calibrations which can be obtained on request from the Atomic Energy Research Establishment, Harwell. Standards of iodine-131, based on the British Standard for this isotope, will be issued on or about October 15, 1953. Future issues will take place twice yearly in mid-April and mid-October. The iodine-131 standards will be in the form of sealed ampoules of solution. Two different levels of activity will be available, one of 1 millicurie in 1 ml. of solution and one of 100 microcuries in 4 ml. of solution. Issues of standards of phosphorus-32 (100 microcuries in 4 ml. of solution) are planned to take place on June 15 and December 1, 1953. Applications for these standards should reach the National Physical Laboratory not later than a fortnight before the appropriate date of issue, and should include a statement of the purposes for which the standards are required. A fee of £ 10 will be charged for each 1 millicurie standard and of £ 5 for each 100 microcuries standard. It is requested that applicants should make their own arrangements for the collection of their standards from the laboratory. An announcement relating to the issue of cobalt-60 standards will be made in the near future.